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IN THEIR APPLICATION TO

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MILLER'S EXPERIMENTS AND THE CONSTITUTION OF MATTER.

MILLER JUSTIFIED.

By PROF. W. TOMBROCK (Holland).

It has already been stated (*The Chemical News*, 1927, CXXXIV, 225 and 244) concerning our planetary system that according to previous investigators the sun moves towards a point in the celestial sphere with a declination of 35° (Newcombe). The speed of the motion in question amounted to about "fifteen miles a second from discussion of the proper motions of the stars" and about "eleven miles a second from spectroscopic observations of motion in the line of sight." (Young, *General Astronomy*, revised edition, 1899, p. 500). These previous observations were concerned with the stars of the Milky Way system; the resulting motion of the sun must therefore be considered as existing in (inside) the Milky Way.

In this way the investigators thus found a Solar Apex with a declination of about 35° and a velocity of about 20 kms. per second.

Miller's direct conclusion from his interferometer experiments was that the sun moves towards a point with a declination of + 68° *with a velocity of at least* 200 kms. per second.

In this connection it may be noted that Stromberg "from spherical star clusters and spiral nebulæ arrived at the conclusion that there is a declination of 56° and a velocity of about 800 kms. per second.

Carl Wirtz of the University Observatory at Kiel, now writes in *Scientia* (1927, XXXVIII, 305) an article entitled:

"DIE SPIRALNEBEL UND DIE STRUKTUR DES RAUMES."

"Alle sichbaren Bewegungen am Himmel setzen sich zusammen aus zwei Komponenten: der eigenen 'pekuliaren' Bewekung des Objekts und dem Spiegelbild der Bewegung des Beobachters, das an verschiedenen Punkten der Sphäre und in verschiedenem Abstand vom Beobachter verschieden zur Gettung kommt. Es ist daher möglich, aus der Gesamtheit der vorliegenden Beobachtunger die Bewegung des Standpunktes gegenöber dem Zentroid der Bewegten Objekte zu ermitteln. Als man das für die Spiralnebel versuchte, ergab sich etwas Unerwartetes. Der als Zielpunkt der Bewegung der Sonne gefundene Ort an der Sphäre hatte keine Beziehung zu dem Apex, den man aus Sternbeobachtungen kennt. Man kann den Punkt ungefähr dadurch angeben, dass man sagt ‚er liegt nicht weit vom Pol der Erdbahn. Die Geschwindigkeit der Sonne gegenüber dem Zentroid der Spiralnebel gab nicht mehr den gewöhnlichen Wert von etwa 20 kms. per sec., sondern rund 700 kms. per sec."

Thus according to Wirtz, the sum moves with a velocity of 700 *kms. per sec.* towards a point with a declination of *about* 66½°.

It is clear that this must be a motion of the Milky Way system as a whole in which the sun as an already moving component takes part.

Miller, as we have seen, deduced from his

interferometer experiments, thus in an entirely *different way, the direct conclusion* that the sun moves with a *velocity of at least 200 kms. per sec.* towards a point with a *declination of 68°*.

Hence Miller is confirmed in that which *concerns these two conclusions and indeed* from observations which are quite separate from his experiments.

PROPOSITIONS.

11. The Special Theory of Relativity is not an exact theory, because (a) it is based on a standpoint which cannot be proved, on a negative result of experiments which throughout will permit of more than one explanation and because (b) it contains a fundamental contradiction, thus an impossibility, whereby it is contrary to reality (*Proposition 1, Supp. 2*) (*Tombrock, De Fout van Einstein*, 1925, Harte, Bergen op Zoom). That is exact which is undeniably true or at least can be so.

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WATER SOFTENING.—A NEW BASE EXCHANGE MATERIAL.

By A WELL-KNOWN ENGINEER.

There is now increasingly severe competition between the two general methods available for the softening of water, that is, lime and soda ash, and the use of Zeolite or Base Exchange Compounds. The relative advantages and disadvantages of these two main principles is in practice a complicated subject, and much depends on the use for which the softened water is intended. The convenience and general advantages of the Bash Exchange treatment for zero hardness are well-known, but one of the chief difficulties is that the equivalent of the temporary hardness passes into the softened water as sodium bicarbonate which is often apt to be a difficult matter in the case of *hard water containing much temporary* hardness (calcium and magnesium bicarbonate). Naturally it is not possible to *have strongly alkaline salts in* any quantity added to drinking water, while as regards boiler feed treatment trouble may result from frothing and priming, giving wet steam, and it is necessary to blow down the boilers at frequent intervals.

For these reasons thers is very much to be said for combining the ordinary lime and soda ash plant with base exchange treatment, especially in the case of large boiler and general industrial plants, that is to say, softening the water first down to 4°-5° hardness with lime and soda ash and then reducing it to zero by base exchange material since the amount of soluble salts added thereby is extremely small while the water is of zero hardness, containing no scale-forming material at all. The most valuable aspect of the base exchange treatment in water softening is of course in the textile and allied industries, the great economy in soap obtained when the presence of alkali in the water is no detriment, such as in cotton dyeing ,wool scouring, bleaching, and laundry work.

Just lately the Paterson Engineering Co., Ltd,, have introduced a new base exchange material known as "Basex," which is stated to be the result of a number of years' investigation and large scale and experimental running. The product is a natural zeolite mineral, suitably graded and treated, as opposed to the artificial sodium silicates and similar substances. Also it is claimed to possess to a much greater degree than nsual the main characteristics of a natural compound, that is stability, mechanical strength, and lack of solubility, so that no gradual diminution of the bed takes place, and at the same time silica and other constituents are not added to the softened water passing through; further the material is guaranteed entirely impervious to carbon dioxide dissolved in the water, and to be very impervious to all acids, while the degree of reactivity, with rapid regeneration by the salt solution, not exceeding 20 minutes after an eight-hour run, approaches or equals tbe usually more unstable artificial compounds. The whole subject is a highly interesting one and undoubtedly the disadvantages of the base exchange method are being gradually reduced as a result of experience and research.

MANUFACTURE OF PIG IRON IN INDIA.

Great development has taken place in the manufacture of iron in India during recent years.

Recently Mr. Richard Mather, B.Met., read an interesting paper on the subject before the Royal Society of Arts:

Pig iron is made in India by the Bengal Iron Company, the Tata Iron and Steel Company, the Indian Iron and Steel Company, and the Mysore Government. The production (to the nearest thousand tons) during the last three calendar years is shown in the following table :—

	1924.	1925.	1926	
Bengal Iron Company	148,000	53,000*	20,000*	tons
Tata Iron and Steel Company	540,000	563,000	609,000	,,
Indian Iron and Steel Company ...	168,000	247,000	253,000	,,
Mysore Iron Works	16,000	17,000	20,000	,,
Total	872,000	880,000	902,000	,,

*Partial operation only.

The total production in India in 1913-14 was only 218,000 tons. It will thus be seen that by 1924 the production was four times the pre-war production and that there has since been a further increase.

Bengal Iron Works.—The works of this Company are situated on the Ranigauj coalfield at Kulti, 142 miles north west of Calcutta. The ore is now drawn from the Singhbhum deposits about 160 miles south-west of the works. The Company makes its coke at the works and possesses five blast furnaces, of which only the newest is mechanically charged. The plant has a rated capacity of 200,000 tons of pig iron annually, but owing to market conditions operations have been on a reduced scale during the last two years. The Company makes only foundry iron, of which the following analysis may be taken as representative :—

	Bengal M.
	%
Total Carbon	3.4
Silicon	1.5—3.0
Manganese	1.0—1.5
Sulphur	0.02—0.05
Phosphorus	0.3—0.4

The above composition is typical of that of Indian pig iron made from Singhbhum ore and ordinary Indian coke. The Bengal Company also makes iron (Bengal P) containing between 0.6 and 1.0 per cent. phosphorus for use in the manufacture of light castings. This is obtained by specially charging into the furnace a suitable proportion of phosphate rock (usually containing iron also) which is obtained from deposits near Tatanagar in Singhbhum. In recent years the greater part of the Company's output of pig iron has been used in its own iron-foundries (the largest in India) and in other Indian foundries. In 1926 the Company produced about 71,000 tons of iron castings.

Tata Iron and Steel Company. — This Company, which produces two-thirds of the pig iron made in India and almost all the steel, has its works at Jamshedpur (formerly Sakchi), about two miles from Tatanagar Station, which is about 155 miles west of Calcutta on the main line of the Bengal Nagpur Railway. The coalfields are north of the works, the distances by rail averaging about 115 miles. Coke is made in a large coke-oven plant at Jamshedpur. Ore is at present being brought from three deposits in Mayurbhanj, south of Jamshedpur, the average haulage being under 50 miles, and from Noamundi in Singhbhum, which is nearly 80 miles south-west of Jamshedpur. Dolomite and limestone are at present brought chiefly from workings in Gangpur State, about 110 miles west-south-west of Jamshedpur.

The Indian Iron and Steel Company commenced the manufacture of pig iron towards the end of 1922 in a newly-erected plant in the coal field near Asansol and about 10 miles from the works of the Bengal Iron Company. The Company has not developed its coal area, but makes coke at its own works from purchased coal. The ore is brought from Gua in Singhbhum and limestone from Gangpur State. The plant consists of two blast furnaces of modern type, of which one makes about 400 tons of iron per day and the other, which has recently been re-lined, is now making about 600 tons daily. The Company does not produce iron castings (other than the small quantity required for its own purposes) nor does it make steel. Thus practically the whole of the iron is made for sale, the bulk of it

being exported from India. Much of the iron exported is of basic quality for steel making.

Mysore Iron Works.—These works were erected shortly after the War and are operated by the Mysore Government. They are situated at Bhadravarti. The plant consists of one blast furnace of rated capacity 60 tons per day and the wood distillation plant (which has already been referred to) for the production of charcoal. This furnace is probably the only charcoal blast furnace in the world which has been erected in recent years. The phosphorus in the pig iron varies between 0.11 and 0.13 per cent. and the sulphur is usually below 0.02 per cent. The iron is used for miscellaneous foundry purposes and for pipes, for which a new foundry was erected last year. During the calendar year 1926 over 8,000 tons of the pig iron were exported.

SOME NEW METALLO-ORGANIC OXONIUM SALTS.

By Taichi Harada.
Takamine Laboratory, Clifton, N.J., U.S.A.

Introduction.

Trimethyltin iodide $(CH_3)_3SnI$, is a colourless liquid becoming brown under the action of sunlight. On withdrawing from the light the solution becomes colourless again. On renewed exposure the colour again appears.

After some time small amounts of colourless crystals appear in the solution. This action was first noticed by Callis in 1922.

He thought that the crystalline compound might be iodonium salt, $((CH_3)_3Sn)_2I\text{-}I$, formed by molecular rearrangement under the action of sunlight. It was considered worth while to study the crystalline compound formed in this photo-chemical reaction. It was, therefore, decided that a more extensive investigation on this subject should be carried out.

When the compound was analysed for iodine, a value in the neighbourhood of 19.5 per cent. was obtained in place of 43.63 per cent. as requirrd for a compound of the iodonium type.

Analysis for tin indicated the presence of three atoms of tin per atom of iodine. It was concluded, therefore, that the formula is inapplicable.

The formula, $((CH_3)_3Sn)_2O.(CH_3)_3SnI, H_2O$ for the compound is proposed by the author from the following experimental facts.

Purified trimethyltin iodide did not give the appearance of any crystals. It was, therefore, thought that the crystalline compound must have been formed by the interaction of impurities which accompanied in its preparation.

An experiment, therefore, was made of a mixture of trimethyltin iodide and tetramethyltin and exposed to the sunlight and moist air. A considerable amount of crystals appeared from the solution whose properties and analysis of tin and iodine contents proved to be identical with those of the compound accidentally obtained from the impure solution by the action of sunlight.

Properties.—The compound is readily soluble in water and alcohol and only slightly soluble in such organic solvents as benzene and ether.

Its aqueous solution is slightly acidic. It decomposes slowly at above 143° C. and melts at about 150° C., depending upon the rate of heating into trimethyltin iodide and trimethyltin hydroxide with a little trace of white substance.

When the aqueous solution of the compound was treated with silver hydroxide, silver iodide was precipitated. On evaporation of the clear filtrate on the water bath it did not leave any substance. However, a peculiar odour was noticed during the evaporation. The volatile substance, therefore, was collected by means of a condenser, in the form of colourless crystals.

The examination of the crystalline compound showed that it was trimethyltin hydroxide. With silver nitrate solution it readily precipitates silver iodide, but on standing or heating, the solution and the precipitate becomes dark brown. The quantitative analysis for iodine and tin conforms the following formula :

$((CH_3)_3Sn)_2O.(CH_3)_3SnI, H_2O.$ (I)

Sometimes lumpy crystals appeared from the solution which, perhaps, may be the same in an impure state. These were, therefore, dissolved in alcohol and heated, the solution then becoming brown and relatively strongly acidic. From this solution, on cooling, colourless srystals were obtained as short needles. This compound is somewhat difficultly soluble in water in alcohol, insoluble in ether and benzene, melts and at the same time decomposes at 221° C. (uncorrected). Its aqueous solutions show much stronger acidic properties than that of the first type of compound. When treated with silver nitrate ,silver iodide is immediately precipitated. With silver hydroxide it precipitates silver iodide, and from the clear

filtrate only trimethyltin hydroxide was again obtained in the pure state by distillation, as in the case of the first compound.

It was found that the contents of tin and iodine agrees to the following formula :

$((CH_3)_3Sn)_2O.HI,\ H_2O$ (II)

If the proposed formula (I) is correct, it might be expected that the compound, $((CH_3)_3Sn)_3O$, or compounds, $((CH_3)_3Sn)_2O$ and $(CH_3)_3Sn$, in liquid ammonia would be obtained by treating with equivalent amount of sodium to the iodine.

Since the compound of type (I) is soluble in liquid ammonia, while the compound of type (II) such as, iodide and bromide are practically insoluble, an experiment was carried out with the iodide, $((CH_3)_3Sn)_2O$ - $(CH_2)_3SnI,\ H_2O$ as follows :

To one molecular proportion 4.03 gr.) of the compound in liquid ammonia solution one molecular proportion of metallic sodium (0.15 gr. by weight) was added little by little. A white precipitate was immediately formed. The solvent was evaporated at room temperature giving the reaction mixture which was washed with water, until it was free from sodium iodide and other dissolved impurities. Thus trimethyltin group, $(CH_3)_3Sn$, and its oxide, $((CH_3)_3Sn)_2O$, were obtained in the quantity expected. The following reaction probably has taken place :

$$[((CH_3)_3Sn)_3O].I + Na \longrightarrow [((CH_3)_3Sn)_3O] \longrightarrow ((CH_3)_3Sn)_2O + (CH_3)_3Sn$$

Same substances were obtained from the action of the compound on trimethyltin sodium which was prepared according to Kraus and Sessions. The reaction may have taken place as follows :

$$((CH_3)_3Sn)_3O.I + (CH_3)_3SnNa \longrightarrow ((CH_3)_3Sn)_2O + 2(CH_3)_3Sn + NaI$$

FORMATIONS.

$((CH_3)_3Sn)_2O.(CH_3)_3SnX,\ H_2O$. It was found that when one molecular proportion of trimethyltin halide was treated with two molecular proportions of trimethyltin hydroxide in hot benzene solution, a crystalline compound was formed whose properties appeared to be identical with those of the compound previously obtained by the action of sunlight on impure trimethyltin halide, and on analysis gave similar results.

From trimethyltin free group : A quantity of trimethyltin group, $(CH_3)_3Sn$, which was obtained by either of the following reactions :

$$(CH_3)_3SnOH + Na \longrightarrow (CH_3)_3Sn + NaOH \quad \text{(I)}$$

$$(CH_3)_3SnX + Na \longrightarrow (CH_3)_3Sn + NaX \quad \text{(II)}$$

in liquid ammonia, was dissolved in moist benzene, along with trimethyltin halide, and this solution was subjected to oxidation in the dark. After some days crystals appeared. However, with dry benzene solution powder-like precipitate was formed, which when treated with alcoholic solution or water, became crystallised. These crystals were similar to those previously obtained.

$((CH_3)_3Sn)_2O.HX,\ H_2O$: When one molecular proportion of trimethyltin hydroxide or oxide was treated respectively with one molecular proportion of trimethyltin halide, under relatively hot alcoholic solution, or of halogen acid, these compounds were formed in crystalline form. The chlorine compound such as $((CH_3)_3Sn)_2O.HCl,\ H_2O$ was prepared when one molecular proportion of trimethyltin hydroxide was treated with one molecular proportion of trimethyltin chloride in hot dry benzene. A heavy liquid, however, settled which readily absorbed water and immediately gave the crystalline compound. It shows, therefore, that water is necessary for the formation of all these crystalline compounds as their water of crystallisation. The direct determination of the water of crystallisation of these compounds was not carried out, since the compounds are slightly volatile and decomposible over dehydrating agents.

If the proposed formula (I) and (II) are correct, the compounds might be expected to dissociate according to the equations :

$$\text{I.} \quad ((CH_3)_3Sn)_3O.X \longrightarrow ((CH_3)_3Sn)_2O + (CH_3)_3SnX$$
$$\text{or} \quad \longrightarrow ((CH_3)_3Sn)_3O + X$$
$$\text{II.} \quad ((CH_3)_3Sn)_2O.HX \longrightarrow ((CH_3)_3SnOH + (CH_3)_3SnX$$
$$\text{or} \quad \longrightarrow ((CH_3)_3SnOH + (CH_3)_3SnX$$

Trimethyltin halides possess a high degree of hydrolysis in aqueous solutions, and trimethyltin oxide with water decomposes into the hydroxide which is a weak base.

The aqueous solution of the first type of halide is weakly acidic, because with silver hydroxide, as already described, on standing or heating becomes alkaline, owing to the formation of the base and which decomposes into trimethyltin hydroxide according to the following equation :

$((CH_3)_3Sn)_2O.(CH_3)_3SnI + AgOH \rightarrow ((CH_3)_3Sn)_2O.(CH_3)_3SnOH \quad H_2O \rightarrow 3(CH_3)_3SnOH.$

Concerning the second type of compound it may be regarded that the compound formed between one molecule of a weak base and one molecule of a strong acid is more stable than that of the first type of compound.

They conduct electric current in alcohol, water, acetone, and liquid ammonia solutions while trimethyltin halide and hydroxide are poor conductors in the same solutions. Further discussion of this subject will be presented in a subsequent paper.

It, therefore, appears that the compounds in question are salts of an oxonium type.

Accordingly, the following conclusion is reached : That the formation of the compound between trimethyltin iodide and tetramethyltin taking place under sunlight may be represented by the following equation scheme :

1. $2(CH_3)_3SnI \rightarrow ((CH_3)_3Sn)_2 + I_2$
2. $((CH_3)_3Sn)_2 + I/2O_2 \rightarrow ((CH_3)_3Sn)_2O$

On the other hand the free iodine reacts slowly with tetramethyltin as follows :

$I_2 + CH_3Sn(CH_3)_3 \rightarrow (CH_3)_3SnI + CH_3I$

3.

and $(CH_3)_3SnI$ undoubtedly reacts with trimethyltin oxide to form the salt.

$((CH_3)_3Sn)_2O + (CH_3)_3SnI \rightarrow ((CH_3)_3Sn)_2O.(CH_3)_3SnI$

4.

SUMMARY.

The formation of the compound, $((CH_3)_3Sn)_2O.(CH_3)_3SnX, H_2O$, from trimethyltin halide by the action of sunlight in the presence of air have been studied and the mechanisms of the formation were interpreted. Identical products have been prepared by the following methods : (A) By oxidising of trimethyltin group along with trimethyltin halide in benzene solution in the dark, and (B) by treating two molecular proportions of trimethyltin hydroxide with one molecular proportion of trimethyltin halide in hot benzene solution.

2. Compounds exhibit salt-like properties, being readily soluble in water, alcohol, acetone and liquid ammonia, and insoluble in benzene and ether. They conduct electric current appreciably in their solutions.

3. When the liquid ammonia solution is treated with an equivalent amount of metallic sodium in respect to the iodine trimethyltin oxide, $((CH_3)_3Sn)_2O$, and trimethyltin group, $(CH_3)_3Sn$, are produced.

4 Compounds of the type, $((CH_3)_3Sn)_2O.HX, H_2O$, have been prepared by treating of one molecular proportion of trimethyltin hydroxide with one molecular proportion trimethyltin halide or one molecular proportion of trimethyltin oxide with one molecular proportion of halogen acid under suitable conditions.

5 They are salt-like properties, being soluble in water and alcohol, and insoluble in nonionising solvents such as benzene and ether.

6. Their melting points and stabilities are higher than those of the type,

$((CH_3)_3Sn)_2O.(CH_3)_3SnX, H_2O.$

General Notes.

BOARD OF TRADE ANNOUNCEMENT.

SAFEGUARDING KEY INDUSTRES.

The Board of Trade give notice that representations have been made to them under Section 10 (5) of the Finance Act, 1926, regarding Ethylene bromide; Lead tetra-ethyl; Monochlornapthalene; and R Potassium hydroxide.

Section 10 (5) of the Finance Act, 1926, is as follows :—

" The Treasury may by order exempt from the duty imposed by section one of the Safeguarding of Industries Act, 1921, as amended by this Act, for such period as may be specified in the order, any article in respect of which the Board of Trade are satisfied on a representation made by a consumer of that article that the article is not made in any part of His Majesty's Dominions in quantities which are substantial having regard to the consumption of that article for the time being in the United Kinfidom, and that there is no likelihood that the article will within a reasonable period be made in His Majesty's Dominions in such substantial quantities."

Any person desiring to communicate with the Board of Trade with respect to the above-mentioned applications should do so by letter addressed to the Principal Assistant Secretary, Industries and Manufactures Department, Board of Trade, Great George Street, S.W.1., within two months from the date of this notice.

WHOLESALE PRICES IN FRANCE, GERMANY, BELGIUM AND ITALY.

The index numbers for April revealed a cheapening of commodities in all four countries under review, the greatest fall (3.8 per cent.) occuring in Italy. Belgian wholesale prices declined by 1.4 per cent. and French wholesale prices by 0.8 per cent., while in Germany the decline was of little significance. Owing to the employment of different base periods, the index numbers are not strictly comparable in magnitude as between one country and another, but some comparision can be made regarding the relative movement of prices.

MEASUREMENT OF MEAN SPHERICAL CANDLE-POWER.

Modern development in lamp design and the increasing use of shades and reflectors in good illuminating engineering candle-power as a basis for describing the light-giving power of lamp, and to-day the use of luminous flux or mean spherical candle-power is almost universal. In the present British Standard Specification for electric lamps, for instance, values of lumens or mean spherical candle-power are scheduled, and in the testing of lamps to this specification it is therefore necessary to use some type of photometric integrator.

A recently published paper describes the underlying principles of this apparatus and the method of making measurements with it in language as free from technicalities as possible, and is the first simple exposition of the subject to be published for the guidance of practical engineers. It is hoped that it will facilitate the more widespread use of this type of measurement, for not only electric lamps, but incandescent gas and other illuminants also may be rated in terms of luminous flux. The paper has been prepared by the staff of the Photometric Section of the National Physical Laboratory and embodies the results of the experience gained there.

WATER SOFTENING.

In this issue we publish an article "Water Softening," describing a new base exchange or zeolite compound, by a high authority on this and kindred subjects.

This "Basex" is a very interesting product, being a natural mineral, graded, hardened, and purified, and is claimed to possess in a very marked degree the characteristic of non-solubility, that is without the addition of silica or other constituents to the water, while at the same time being as practically chemically reactive as artificial zeolite, and allowing regeneration by means of salt solution in 10 minutes after an 8-hour run on hard water. No base exchange compound is of course perfect, and the main difficulty with natural minerals is lack of reactivity and with artificial zeolites solubility in water, although the advantages of the method in general are obvious.

DRAWBACK ON IMPORTED MATERIALS USED IN CANADIAN MANUFACTURES.

CELLULOSE ACETATE IN POWDERED FORM AND YARNS PRODUCED FROM CELLULOSE ACETATE, DRY SPUN.

The following regulations have been established by Order in Council (P.C. 896) dated the 18 day of May, 1927, under the proivsions of Section 286 of the Customs Act :—

REGULATIONS.

1. The following articles, when used in Canadian manufactures, may be granted a drawback of the duty paid on the following items at the rate of drawback herein inserted :—

(a) On cellulose acetate in powdered form, when imported after the thirty-first day of October, 1927, and prior to the first day of May ,1928, by manufacturers and further manufactured in their own factories before the first day of June ,1928, there may be paid a drawback of ninety-nine per cent. of the duties paid on the cellulose acetate in powdered form so used ;

(b) On yarns produced from cellulose acetate ,dry spun, not more advanced than singles, when imported after the thirty-first day of July, 1927, and prior to the first day of February, 1928, by manufacturers and further manufactured in their own factories before the first day of March, 1928, there may be paid a drawback of eighty per cent. of the duties paid on such yarns so used.

2. Provided, however, that the said drawback shall not be paid unless the customs duty has been paid on the materials so used as aforesaid within the time specified in (a) and (b).

ABRASIVES.

Report on Abrasive Materials and their Uses of Unusual Interest.

Abrasive materials play a very important part in modern industry and in the modern home. Metal polishes for silver, for nickel, or for brass are familiar to every one; French polishing as applied to pianos and fine furniture is accomplished by the use of certain kinds of abrasives; buffed and suede leathers owe their characteristic surface finish to the correctly applied tearing action of minute particles of an abrasive such as garnet; the accurate grinding and honing of engine cylinders that is necessary in the production of the modern gasoline engine as used in motor cars, in motor boats, or in air planes is possible by applying suitable abrasives.

The great importance of these non-metallic mineral products led the Mineral Resources Division of the Mines Branch, Canada, to investigate the production and use of abrasive materials in Canada. As a result of these investigations the Mines Branch has recently issued a monograph on abrasives by V. L. Eardley-Wilmot. It was found necessary to subdivide the report into four parts, which are to be published separately. The first part, which deals with siliceous abrasives of all kinds, including such materials as quartz and pumice, will probably be issued in August; the second part, dealing with corundum and diamond, is now ready for distribution; the third part, treating of garnet and its uses, is also ready for distribution; the fourth part, dealing with artificial abrasives and manufactured products, is now in press but will not be issued for some months.

This series of valuable monographs describes in considerable detail all the principal deposits of natural abrasive materials in Canada which have been discovered and developed; treats of the characteristics and trade requirements of abrasive products; and describes methods of preparation for markets and the various industrial applications of each material.

This group of reports constitutes a very valuable and useful addition to the series of monographs on industrial minerals that has been issued by the Mines Branch. Copies of Part II. (Report No. 675), Carborundum and Diamond; and Part III (Report No. 677), Garnet; may be obtained now upon application to the Director, Mines Branch, Department of Mines, Ottawa, Canada.

IONISATION BY COLLISIONS OF THE SECOND KIND IN THE RARE GASES.

By Gaylord P. Harnwell.

Abstract from the *Physical Review*, U.S.A.

A positive ray apparatus was used to investigate the products of ionisation hy electron impact in mixtures of helium, neon, and argon. The variation with pressure of the ratio of the two types of positive ions present was investigated in detail for three cases. Case 1: A mixture of half helium and half neon was investigated up to 0.15 mm pressure. The ratio He^+/Ne^+ was found to decrease regularly between 0.03 mm and 0.15 mm. At 0.03 mm the mean free path is approximately equal to the dimensions of the apparatus. The suggested reaction is: $Ne + He^+ \rightarrow Ne^+ + He$. Case 2: A mixture of half neon and half argon was investigated throughout the same pressure range. The ratio Ne^+/A^+ decreased regularly between 0.05 mm and 0.15 mm, but this decrease was less rapid than that of the ratio in Case 1. The suggested reaction is: $A + Ne^+ \rightarrow A^+ + Ne$. Case 3: This mixture was half helium and half argon, and the pressure range was the same as iu the first two cases. The ratio He^+/A^+ remained constant within the limits of experimental error. Case 3a: A mixture of 15 per cent. helium and 85 per cent. argon were also investigated as there were theoretical grounds for believeing that the rate of variation of He^+/A^+ with pressure would be greater in such a mixture. In that case the ratio $He^+/^+$ was found to decrease slightly. The suggested reaction is: $A + He^+ \rightarrow A^+ + He$.

The observed effects are best explained by a type of collision of the second kind which is equivalent to ionisation by positive ions. To account for the results obtained an electron must be transferred from an atom to an ion as a certain fraction of the collisions between an atom and an ion of higher ionising potential. The results obtained at low pressures corroborated the values for the probability of ionisation in these gases obtained by K. T. Compton and C. C. Van Voorhis.

CATALOGUES.

British Drug Houses catalogue in alphabetical order, with prices of the various pure chemicals for research and analysis.

Donovan & Co. Manufacturing electrical engineers, Cornwall Street, Birmingham. Illustrated catalogue and price list of 56 pages.

MAGNETIC RELUCTIVITY RELATIONSHIP.

By RAYMOND L. SANFORD.
(*U.S.A. Bureau of Standards.*)

ABSTRACT.

An experimental and theoretical study of the magnetic properties of pure iron near saturation has led to the conclusion that the so-called reluctivity relationship of Kennelly does not truly represent the properties of pure and homogeneous materials, and that the constants in the reluctivity equation are without physical significance. The Kennelly formula and one recently proposed by Gokhale have practical value, each within its own range, for interpolation and extrapolation.

The conclusion that the constants in the reluctivity formula are without physical significance makes the problem of correlating the magnetic properties more difficult. A new basis for correlation must be sought.

SUMMARY AND CONCLUSIONS.

To recapitulate briefly : The problem of the correlation between the magnetic and other physical properties would be much simplified if a formula were available for expressing the magnetic properties in terms of constants having a definite physical significance.

It has for some time been considered that the Kenelly law of magnetic reluctivity represented the magnetic properties of magnetically homogeneous materials, and it was hoped that the constants might have some definite physical significance. Gokhale has called this view into question and proposed a substitute formula. While his experimental evidence did not seem to be conclusive and his proposed formula has no better theoretical foundation than the Kennelly law, it appeared worth while to make a further study of the subject. Such a study was carried out with the follolwing conclusions :—

1. The characteristic curve between magnetisation and permeability for pure materials near saturation has a point of inflection and double curvatnre, and is not straight as called for by the Kennelly relationship. This view is upheld by experimental evidence and theoretical considerations.

2. Since the reluctivity curve for pure and homogeneous materials is not straight, but only apparently so, on account of the insensitive nature of the curve, the true saturation value is not indicated by the reciprocal of the slope of the curve and the value of the intercept has no physical significance.

3. While the Gokhale formula fits the observed curve near saturation better than the Kennelly formula, it is developed from a basic assumption having no better physical foundation and it is improbable that its constants have a physical significance.

4. Both formulas are useful, each in its own range, for interpolation. The Gokhale formula is better for extrapolation, provided data are available for values of H greater than 500 gilberts per centimeter.

5. In the light of these conclusions the reluctivity relationship has a limited value, if any, in connection with the problem of the correlation between the magnetic and other physical properties of ferromagnetic materials, and a new basis of correlation must be sought.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read at the meeting on Thursday, June 23 :—

On the Wave-Length of the Green Auroral Line in the Oxygen Spectrum. By J. C. McLENNAN, F.R.S., AND J. H. McLEOD.

In 1925 McLennan and Shrum found a line in the spectrum of highly purified oxygen of wave-length λ 5577.35 $\pm$ 0.15, and provisionally identified it with the green auroral line. Re-investigation with a Fabry-Perot interferometer now determines the wave-length of this line as 557.341 $\pm$ 0.004.

Babcock's value for the wave-length of the auroral line being 5577.350 $\pm$ 0.005, there would thus seem to be no doubt as to the identity of the lines. It would thus appear that oxygen as well as nitrogen must be present in those regions of the upper atmosphere whence the auroral light is transmitted.

The Combination of Nitrogen and Hydrogen Activated by Electrons. By A. CARESS AND E. K. RIDEAL. Communicated by T. M. Lowry ,F.R.S.

A study of the combination of nitrogen and hydrogen to form ammonia in a triode valve has been made. It is shown that hydrogen atoms formed by thermal dissociation at a hot tungsten emitter will combine with nitrogen at platinum and nickel surfaces to form ammonia. Hydrogen atoms excited by collision with ca. 13-volt electrons will react with molecular nitrogen in the gas phase to form ammonia. In the absence of hydrogen atoms (by using a mixed barium calcium oxide emitter) no formation of ammonia is observed until a voltage of

17 volts is attained ! a further rise in rate of formation is noted at 23 volts. These two rises are attributed to the chemical reactivity of N_2^+ and N^+.

It is shown *inter alia* that H^+ ions will reduce the oxides of the alkaline earths. From a study of the rate of formation of ammonia with different types of grids, it is suggested that ammonia is produced by interaction of N_2^+ and N^+ with hydrogen to form primarily excited hydrogen atoms.

The electron-efficiency of ammonia-formation from nitrogen ions has been shown to be at least one ammonia molecule produced for the passage of four electrons ;in the case of excited hydrogen atoms the efficiency appears to be even higher.

The Total Ionisation Due to the Absorption in Air of Slow Cathode Rays. By J. F. LEHMANN AND J. H. OSGOOD. Communicated by Sir Ernest Rutherford, P.R.S.

Experiments were undertaken to determine ionisation produced by complete absorption in air of slow cathode rays. Electrons ejected from a hot tungsten filament were accelerated to an anode, by a potential difference of 200 up to 1,000 volts. A portion of these electrons passed through a carbon capillary into an ionisation chamber. The air pressure in this chamber conld be maintained at any required value, below 2 mm. Hg., by means of a capillary leak from a gas pipette. Air leaking from the ionisation chamber to the filament chamber, was removed by high-speed diffusion pumps.

The electron current entering the ionisation chamber and the positive ion current due to the absorption of these electrons, were measured alternately. Ratio of ionisation current to electron current gave average ionisation per electron. Using an electron bea mof given initial energy, ionisation per electron was approximately proportional to pressure of absorbing air, provided this pressure was less than a certain " critical pressure." For greater pressures ionisation per electron was constant. The magnitude of the critical pressure was determined by the initial energy of the electron beam.

Ratio of ionisation current to electron current, at pressures greater than critical pressure, represents average total ionisation due to complete absorption of an electron. This was found directly proportional to initial energy of electron, and the ratio,

$$\frac{\text{initial energy of electrons}}{\text{average total ionisation per electron}}$$

gave average energy expenditur eassociated with formation of a pair of ions. This average per ion pair was 45 electron-volts, whereas the ionisation potential of air is 17 volts. It is evident that in air a considerable portion of initial electronic energy is dissipated in processes other than simply separatin gthe molecule into positive and negative ion.

THE FARADAY SOCIETY.

The following paper was read at the meeting on April 28, 1927 :—

The Activity of Zinc Chloride in Concentrated Solution. By F. FOXTON AND W. J. SHUTT.

The electrochemistry of fused salts is essentially simpler than that of aqueous electrolytes in that one component (water) is eliminated from the system. Thus it might be expected that the properties of molten electrolytes would ultimately prove simpler than those of the corresponding aqueous solutions. On examination, however, the behaviour of fused salts presents the anomaly of indicating a high degree of molecular association, while at the same time all the phenomena usually coupled with high or complete electrolytic dissociation are observed.

In a review of the accnmulated data regarding the constitution of fused salts, R. Lorenz showed that the application of the many fused salts indicated an association to the extent of at least four molecules to each aggregate. This conclusion was further borne out by the work of Walden on the latent heats of fusion and vaporisation of such melts.

A similar anomaly has been observed by McBain and co-workers in the case of concentrated solutions of soaps. Their results have indicated the presence of highly charged aggregates " ionic micelle ") consisting of large complexes of fatty ions appreciably hydrated. The high electrostatic charge of the micelle ensures it a high mobility despite its relatively large dimensions.

It seemed that it would be of interest to examine the properties of that type of electrolyte which lies between the conditions of aqueous solutions and those of fused salts. This paper is a description of the investigation of the electromotive forces of cells containing an electrolyte in aqueous solutions so strong as to approach the conditions of molten salts. The electrolyte chosen was zinc chloride. This salt has, at ordinary temperatures, a high solubility which increases continuously as the temperature

rises; it also furnishes ions which are reversible with respect to massive electrodes both in aqueous solution and in the fused state.

EXPERIMENTAL.

Apparatus.—The preparation of a reliable zinc electrode presented less difficulty than had been expected from the literature. Pure zinc was cast in hot graphite moulds to the form of small cylinders, which were turned on the lathe to give a bright smooth surface. Success depended on the preservation of this surface from any trace of grease and this was attained by immediate immersion of the freshly turned rods in pure benzene. Shortly before use the electrodes were washed with alcohol and water and plated in an ammoniacal solution of zinc sulphate, as recommended by Richards and Lewis. The electrodes prepared in this way were placed in half element vessels designed to ensure that the zinc was entirely below the surface of the liquid in the thermostat.

Platinum and carbon presented themselves as suitable media for the chlorine electrode. As it was feared that the former might cease to remain passive at the high temperatures to be employed, it seemed desirable to devote considerable attention to the behaviour of carbon, especially as the latter had been previously studied at high temperatures, notably by Lorenz and Fox, who had shown that the carbon-chlorine electrode is reversible and gives readily reproducible potentials in molten chlorides of heavy metals. The results were disappointing, however. At ordinary temperatures, even with electrodes of the smallest possible dimensions, the time required for attainment of equilibrinm was inordinately long, and up to 60° C. it was impossible to reproduce the potential of such an electrode with greater precision than about 10 millivolts. The results seemed to indicate that, at temperatures higher than those employed in this work, carbon might function satisfactorily and replace the platinum electrodes which had perforce to be used for this research. The metal was platinised for use in solutions below about molal strengtb, but with higher concentrations bright platinum prove dquite satisfactory. The chlorine, prepared by the action of pure hydrochloric acid on cold solid potassium permanganate, was stored over sulphuric acid, and tests by absorption in alkali indicated a purity of over 99.7 per cent. for the gas.

VAPOUR PRESSURE MEASUREMENTS.

The interpretation of the results obtained by the use of a chlorine gas electrode involves a correction for the partial pressure of the gas and, since data for the vapour pressures of zinc chloride solutions under the conditions employed were lacking, it became necessary to measure these values to an accuracy of about + 3 mm. of mercury.

For vapour pressures at 60.48° C., a modified form of isoteniscope was used. At this temperature little difficulty was experienced in establishing equilibrium between the solution in the bulb and manometer of the isoteniscope. Dilution of the solution by condensation of water during cooling was avoided by sealing the isoteniscope from the vacuum reservoir and gauge at a point immediately above the surface of the thermostat. The bulb was broken from the isoteniscope and its contents analysed after cooling.

At 80.4° C. the isoteniscope proved unreliable and a comparison method was adopted. Two solutions, one of zinc chloride and the other of sulphuric acid, were placed in bulbs, connected by wide tubing. After evacuation the system was sealed and placed in the thermostat, where it was gently shaken for at least two hours. The breaking of a fine capillary tube permitted air to enter the apparatus and practically stopped further distillation during cooling. The contents of both bulbs were analysed. Qualitative tests showed that no mixing had occurred. Sulphuric acid solutions were chosen as reference substances since their vapour pressures have been thoroughly worked out by Burt for a wide range of concentrations and temperatures. Points on the curve were checked at comparatively low concentrations by the replacement of sulphuric acid by saturated solutions of sodium carbonate and sodium sulphate respectively, whose vapour pressures have been determined by Gerasimow and P. Pawlowitsch.

THE PHYSICAL SOCIETY.

Proceedings at the Special Meeting held at the Special Meeting held at the Imperial College of Science on Friday, June 3, D. Owen ,B.A., D.Sc., in the chair :—

A Lecture on the Eclipse of the Sun was delivered by E. H. Rayner, M.A., Sc.D.

EXTRACTS FROM LECTURE.

The initial partial phase and totality take place before 6 a.m. G.M.T. In such circumstances the diurnal rotation causes England to have a small component opposite to the eastward motion of the moon's shadow. The final (fourth) contact will occur after

6 a.m. over England, and the partial phase at commencement will be some $3\frac{1}{2}$ minutes shorter than that after totality. The times mentioned in this lecture are G.M.T. The centre of the shadow cone makes first contact with the earth at 5H. 20.1M.. G.M.T., only 3 minutes before it reaches Cardigan Bay. At this point the diameter of the cone, where it intersects the earth is about 13.7 miles, and the distance of intersection from the imaginary point is about 1,500 miles. In the two succeeding minutes, when the intersection is near Hartlepool, the diameter increases to about 16 miles, corresponding to about 1,700 miles from the point. Owing to the low altitnde of the sun, the intersection of the shadow cone with the earth's surface is a long ellipse. The minor axis of the ellipse is only about half of the 30 mile width of the shadow track, since the major axis of the ellipse is inclined at about 23° to its direction of motion. One result of these circumstances is that over the northern two-thirds of the shadow-track the approach of the shadow will appear to be from the E. of S. and not fro mthe S.W. The direction at Richmond will be about 15° E. of S. The apparent velocity will be considerably less than the velocity of travel.

Particulars for Richmond, Yorks.

The progress of the eclipse has been computed for the Race Course at Richmond, Yorkshire. The information includes the times of the four contacts and their position angles. The moon will first be seen to encroach on the sun at 4H. 30M. 37S. at angle of 293° from the vertex, that is, from the highest point of the sun as seen at that time and place. The angles are computed starting from North through East, to the left. The point is more conveniently found by considering it as 67° from the vertex counting towards the right.

The passage of the leading edge of the moon across the sun's disc takes about 54 minutes, the second contact, which is the commencement of totality, occuring at 5H. 24M. 39.9S. Totality is computed to last 22.8 seconds ending with third contact at 5H. 25M. 3.7S. The fourth contact, when the sun is finally clear of the moon, is about 57.5 minutes later.

THE OPTICAL SOCIETY.

June 9, 1927.

The Use of Photo-Electric Cells for the Photometry of Electric Lamps. By T. H. Harrison, Ph.D., B.Sc., A.Inst.P.

A description is given of apparatus and experiments designed for giving the highest accuracy and precision in the photometry of electric lamps using photo-electric cells. Although the methods adopted are not novel, yet every care has been taken to obtain the highest sensitivity in the photoelectric correct measuring apparatus and to maintain the lamps at a steady accurately known voltage voltage. It is claimed therefore, that the results are useful in showing the maximum capabilities of photoelectric cells when used in the usual manner with a sensitive electrometer or electroscope

The actual results are tabulated. A discussion is given of the sources of error to be expected, of the method by which they may be avoided, and of the computation of the accuracy of the results.

An Experimental Study of the Best Minimum Wave-Length for Visual Achromatism. By R. Kingslake, A.R.C.S., D.I.C., M.Sc.

A special telescope is described, in which the chromatic aberration can be varied continuously by means of a zero-power lens sliding within the telescope tube, the conditions being such that this movement does not introduce any other underisable aberrations. This apparatus has been constructed, and by its aid many determinations have been made as to the best type of achromatism for visual observations, in daylight, in artificial light, and on astronomical objects. Several observers were employed to make settings, and their opinions as to the most desirable type of achromatism are tabulated and compared. In general it is found that a moderate amount of under-correction is needed to give a truly colour-free image, that less under-correction is required if the best definition is to be obtained, and that a slight over-correction is desirable for astronomical work.

On Brewster's Band. Part II. By Sushil Krishna Datta, M.Sc., A.Inst.P.

This paper is a continuation of the one already published under the same title. It discusses the nature of the patterns obtained by the super-position of two systems of Haidinger's rings when the actual law of spacing of the rings is taken into consideration. Figures are reproduced illustrating the patterns, and a theoretical deduction of these is given.

THERMAL EXPANSION OF GRAPHITE.

By Peter Hidnert and W. T. Sweeney.

ABSTRACT.

This paper gives the results of an investigation on the thermal expansion of longitudinal and transverse sections of artificial graphite electrode (99.2 to 99.7 per cent. carbon) over various temperature ranges between room temperature and 600° C.

A summary of available data by previous observers on the thermal expansion of graphite (natural and artificial) and of other forms of carbon is included.

In the present investigation the coefficients of expansion of graphite were found to be low. The transverse samples expand considerably more than the longitudinal samples (approximately 45 per cent). For both the longitudinal and transverse samples the coefficients of expansion decrease slightly as the purity (carbon content) increases. The table in the summary gives a *résumé* of average coefficients of expansion derived from the data on all samples for various temperature ranges between 20 and 600° C.

SUMMARY.

The coefficients of expansion of graphite are low. For example, the coefficient of expansion of ordinary steel is about six times the coefficient of longitudinal sections of graphite and about four times the value for transverse sections between 20 and 100° C. The transverse samples expand considerably more than the longitudinal samples (approximately 45 per cent). The coefficients of expansion of all samples increase with temperature. For the longitudinal and transverse samples the coefficients of expansion decrease slightly as the purity (carbon content) increases.

BRITISH INDUSTRIES FAIR.

Available exhibiting space for the 1928 British Industries Fair, at the White City, which has been leased also for the following two years, exceeds that provided last year by 100,000 square feet. Extensions amounting to 80,000 square feet are to be made at Birmingham. The schedule of exhibits at both centres has been slightly revised.

NOTICES OF BOOKS.

Chemical Technology—Problems in the Teaching of this Subject.

Unterrichtsprobleme in Chemie und chemischer Technologie im Hinblick auf die Anforderungen der Industrie. Dr. Wolf James Muller. *Published by* Julius Springer, Vienna. Pp. 17. Price 1 mark.

This pamplet is Dr. Muller's lecture given on the occasion of his taking up the post of professor of inorganic chemical technology at the Technical High School, Vienna.

Dr. Muller has got something to say but he gets up to page 14 before he says it. His long preamble is a historical re-statement of the position in Germany as regards chemical technical education, showing how that Germany in the past specialised on organic chemistry to the virtual exclusion of inorganic chemistry in its high schools, technical schools and universities, and how that this short-sighted policy was paid for during the Great War and afterwards (when the dye-monopoly was broken). Dr. Müller then goes on to explain that his idea of inorganic technical chemistry is in fact nothing more than chemical engineering, and he states that the present day system of training in German and Austrian technical schools produces persons who are regarded by chemists as engineers and by engineers as chemists, or as we should say "Jack of both trades but master of neither."

Present methods of training and present day opinion on those methods varies between two wide extremes. Manufacturers say, "Give chemists who are chemists and we will teach them the practical technical side of their work in our factories" whereas, some technical schools clamour for an additional period of training for students after qualifying for their degrees, but this training to be exclusively in factories or in laboratories on technological problems only. America has solved the problem by arranging for its technological students to work in factories during the vacations, and this system has been followed in Darmstadt where the technical high school has made arrangements for the training of students during vacation in the Darmstadt Gas Works.

The next problem is this :—What are we to regard as technical inorganic chemistry and how is it to be taught. Dr. Müller considers a definition of "chemical engin-

eering " as given by the U.S. Committe on Chemical Engineering Education as sufficiently comprehensive and proceeds to outline the main idea of his lecture *viz.*, his scheme for training the young Austrian technological chemist. The subject (chemical engineering) is divided into 4 main groups :—

(*a*) Transporting and Mixing (Mengenbestimmung) processes.

(*b*) Prepatory and manufacturing processes.

(*c*) Separation processes.

(*d*) Reaction processes.

and each of these groups is divided according as to the materials are solids, liquids or gases and in the case of (*c*) and (*d*) as to the resulting components *i.e.*, solid-solid; solid-liquid, solid-gas, liquid-liquid, liquid-gas, gas-gas, and then further subdivision is obtained by separation of processes into mechanical heat processes, and electrical or magnetic processes.

The pamphlet will be of great interest to technical schools and modern chemical factories.

J. H. A.

James Blythe Rogers. By EDGAR F. SMITH. Pp. 14. Philadelphia. 1927.

Prof. Edgar F. Smith has done much to bring the lives of American chemists to public notice and his booklet on the life of James B. Rogers (1802-1852) will be widely read with the anticipation of sustained interest. In England many of the early American scientists are almost unknown, yet there were many who, like James Blythe Rogers, have given their contribution to the advancement of science.

He published several contributions dealing with analytical chemistry and many improvements in the manufacture of chemical products in America were due to him.

J. G. F. D.

FORTHCOMING EVENTS.

ROYAL INSTITUTION.

21, Albemarle Street, W.1.

Monday, July 4, at 5 p.m.—General Meeting of the Members.

INSTITUTE OF CHEMISTRY OF THE AMERICAN CHEMICAL SOCIETY.

The A. C. S. Institute of Chemistry will be held from July 4 to 30 at the Pennsylvania State College, Pa. The Institute proper lasts from July 4 to 30. Courses for college credit extend from June 25 to August 5. The Institute is a national affair, and students will be in attendance from all over the country. A section of new fraternity houses in one of the most attractive parts of State College has been taken over to house members of the Institute and lecturers. Some of these houses are reserved for women, and others for married couples.

The committee in charge, consisting of N. E. Gordon, B. S. Hopkins, C. E. K. Mees, C. M. A. Stine, G. L. Wendt, F. C. Whitmore, W. R. Whitney, and F. W. Willard, has arranged a programme consisting of (1) A series of daily conferences; (2) Intensive courses of lectures carrying college credit: (3) Evening talks on popular science subjects; (4) Exhibits and educational films.

In addition to the educational phases of the Institute, the committee is arranging excursions, picnics, golf and tennis tournaments, and other recreational features, such as dancing and horseback riding.

CORRESPONDENCE.

A.S.L.I.B. DIRECTORY.

38, Bloomsbury Square,
London, W.C.1.
June 28, 1927.

(*To the Editor of the* CHEMICAL NEWS.)

Dear Sir,

May I be allowed through the medium of the Press to offer my thanks to all those who have kindly responded to my request for information in connection with the preparation of the Directory of Sources of Specialised Information, and at the same time beg those who could assist but have not yet written to me to do so at once, as we are fast approaching the close of our work. I should especially like to be able to include some more collections in the possession of private individuals.

Yours faithfully,
G. F. BARWICK,
Secretary.

CUPRATES.

By Robert Saxon, B.Sc., F.C.S.
(Member of the American Chemical Society).

The author has suggested in the *Chemical News* that from the behaviour of copper pyrites under electrolysis the compound is the sulpho-cuprate of iron. Experiments on mixtures of chlorides, nitrates, or sulphates of iron and copper seem to point to the existence of a series of salts in which the positive iron ion throws over the copper to the negative side along with the anion. These mixtures in every case, whether the reagent is in defect or excess, give with sodium, potassium, or ammonium hydroxide a precipitate of composition corresponding to the formula $FeCu(OH)_5$ where the ferric salt is used and $FeCu(OH)_4$ with the ferrous. The latter salt is green like the ferrous salts, and the former brown. *Excess of ammonia does not give any blue colouration*, nor will ammonia dissolve any of the compounds on a filter paper, *except after standing* with them for hours, and then there is only a faint blue, no matter how much ammonia is used. It would seem that iron gives copper no chance as a positive ion, for very little iron (1.0 per cent.) will effectively prevent the formation of the blue compound, even when the iron should be satisfied. Under the circumstances it seems that the copper takes up the chlorine to form a compound anion as $CuCl_4$ or $CuCl_5$ to form what may be termed chloro-cuprites, and chloro-cuprates of iron. The double cyanides of copper are similar to these double chlorides, as in them there is no evidence of the existence of blue basic cuprion, but the iron manifests its usual green or brown basic ion, and not at all the red or yellow colours it assumes in the negative camp as ferrate, ferri-cyanide, or ferro-cyanide.

NEW ALBERTA GEOLOGICAL REPORT.

The Scientific and Industrial Research Council of Alberta at Edmonton (Canada) has just issued its report No. 17 by Ralph L. Rntherford, entitled "Geology along the Bow River between Cochrane and Kananaskis, Alberta."

This report contains the results of a geological survey of a belt about ten miles wide across the entire width of the foothills along Bow River.

The object of this survey was to determine the thickness and character of the various formations, and to work out the geological structure. This has been accomplished in a satisfactory manner by the author of this report.

New Patents.

These particulars of New Patents of interest to Readers have been selected from *the Official Journal of Patents, and are* published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

15,183.—Aktiebolaget Separator-Nobel. —Removal of paraffins from fluid hydrocarbons. June 7th.

15,294.—Blagden, J. W.—Manufacture of crystalline menthol. June 8th.

15,005.—British Dyestuffs Corporation, Ltd.—Dyeing. June 7th.

15,528.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of dyestuffs. June 10th.

Specifications Published.

244,463.—Badische Anilin & Soda Fabrik. —Manufacture of new anthraquinone derivatives.

247,219.—I. G. Farbenindustrie Akt.-Ges. —Process for the production of phosphorus.

271,969.—Synthetic Ammonia & Nitrates, Ltd., Smith, P. A., and Smith, A. G.—Production of acid amides and salts.

261,388.—Muller, K.—Method of purifying gases for the synthesis of ammonia.

261,747.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of amines of the cyclohexane series.

Abstract Published.

269,243.—Fungicides, etc.—Du Pont de Nemours & Co., E. I. Wilmington, Delaware, U.S.A.

Fungicides; insecticides; organo-mercury compounds. — Organo-mercury compounds for use as fungicides, insecticides, and seed disinfectants are synthesised by reaction between a mercury oxide or salt and an

aromatic organic compound such as a phenol in the presence of a relatively insoluble substance adapted to act as a vehicle or diluent for the organo-mercury compound so formed. The diluent may be completely inert, or may react with the initial materials or with intermediate products formed in the synthesis of the organo-mercury compound, and may be of basic ,neutral, or acid character. Diluents specified are calcium or magnesium hydroxide or carbonate, aluminium oxide, barium carbonate or sulphate, clay, charcoal, infusorial earth, and calcium phosphate. The reactions specified in examples are those between hydrated lime, mercuric acetate and ortho-chloro-phenol, between mercuric acetate and ortho-nitrophenol sodium, between mercuric bichloride, sodium hydroxide and ortho-chlorophenol, and between mercuric acetate and betta-naphthol. In each case a water solution or suspension of the reagents, containing also an insoluble diluent, is heated to about 80° C. for several hours and the residue filtered off, dried, and powdered. The active material forms a surface layer on the particles of the diluent and not a mere mixture therewith.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

BAUMATTE.

478,574.—All goods in Class 1 which includes acids, potash, salts and other chemical substances used in manufactures,—Montgomerie, Stobo and Company, Limited, Victory Works, George Street, Bridgetown, Glasgow. June 15th.

PURDEMAND.

479,890.—All goods in Class 1 which includes acids, potash, salts and other chemical substances used in manufactures.—George Purdon & Co., 40, Commercial Road, London, E.1. June 15th.

GLASIL.

479,874.—All goods in Class 2, which includes chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—Parker & Wood, Springfield Lane Oil Works, Springfield Lane, Salford, Manchester. June 15th.

NAPHACID.

480,645.—Chemical substances used in manufactures, photography, or philosophical research, and anti-corrosives.—Sterns, Limited, 16, Finsbury Square, London, E.C.2. June 15th.

EXCELLENT OPPORTUNITY for trustworthy men as Spare Time Representatives for well-known Wireless Manufacturers. Good commission paid. Applicants must have knowledge of wireless installation and be able to furnish good references. —Write Box J. M. W., c/o *Chemical News* Merton House, Salisbury Square, London, E.C.4. (T.C.)

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A SELECTIVE DISPLACEMENT OF 0.0153A IN X-RAY SPECTRAL LINES. PART VIII.

By F. H. LORING.

It has been shown in these studies that it is possible to evaluate Δ_α from the HeII line $\lambda = 4685.81$, but this was regarded as a possible chance coincidence. However this may be, if the so-called evaluation is shifted to the lowest component of the fine-line structure of He, *viz.* : 4685.307—referring to the 4686 line in general—then a set of values are derivable which make it possible to bring *all* the constants into agreement with experiment. In referring to the 4685.307 value attention may be drawn to the work of Paschen (*Annalen*, 1916, L, 901).

It was tentatively suggested that the R_{inf} constant could be evaluated from Δ_H and c. The slightly reduced value obtained for Δ_H by using the value 4685.307 brings about an exact agreement when R_{inf} is taken as 109737.2, which is the mean between the best value giveu by Birge (109737.3) and that given by Paschen (109737.1)—see Part VII. Or, taking this mean value, the velocity of light (c) comes out at 2.9979597, which is in exact agreement with Michelson's new determiuation 2.99796, both values being multiplied by 10^{10}.

The higher infinity value 109891 now reduces to 109889.72, which makes up as follows : $109737.2 + (0.0152516 \times 10^4)$.

The equations given in Parts V and VI are now in complete harmony so that all the following values are in correlative agreement. In these calculations π is taken as 3.14159265 and π^2 9.8696044. The calculated values are given further in the decimal region than the experimental basic values warrant, but as errors often tend to cancel out this procedure was adopted, especially as the agreements are close.

(1) He λ 4685.307 (Paschen).
(2) $\Delta_{He} = 4685.307/(8 \times 10^2) = 5.85663375.$
(3) $\Delta_H = \Delta_{He}/(16 \times 10^0) = 0.3660396.$
(4) $\Delta_x = \Delta_H/(24 \times 10^0) = 0.01525165.$*
(5) $h = 10^{-28}/\Delta_x = 6.5566676 \times 10^{-27}.$
(6) $e/m = 1.767488 \times 10^7 \times c.$†
(7) $e = 4.779 \times 10^{-10}.$
(8) $c = 2.99796 \times 10^{10}.$
(9) $R_{inf} = 109889.72 = 109737.2 + (0.0152516 \times 10^4).$
(10) $R_{inf} = 109737.2$ (see above).
(11) $R_{inf} = c\Delta_H \times 10^{-5} = 109737.21.$

* This is near to the value derived by experiment, the mean of which came out at 0.015250 (see Part V).

† In the equations given in Part VI, c^2 includes this c.

When Δ_H is calculated from Sommerfeld's equation given in this Journal p. 291 of vol. cxxxiv, using the appropriate constants as given in the above table, it comes out at 0.36603. When this quantity is evaluated from the 4685.307 line of He it comes out at 0.366039. . . .

The higher R_{inf} value shown in line 9 may perhaps be reconciled with the higher Δ_{He} shown in line 2 by the following procedure: 5.85663375 0.01525165 = 5.84138 . . ., so that 5.84138 . . . /16 = 0.365086.

This correction, if permissible, was not used in the calculations as expressed by the above table. The higher R_{inf} was used (9).

Attention may be drawn to critical remarks scattered throngh these papers. There is no need to repeat them here. The only points to be made are: that all the tabulated values are in correlative agreement; and, three independent methods are involved, *viz.*: (1) experimental, particularly in getting out the close value for Δ_a, (2) Sommerfeld's equation, (3) the more complete equations involving e/m = 1.76749, which value is in fair agreement with the values of Paschen and Houston, as cited in Part VII. The mean between the Paschen-Houston and the Birge values is 1.7643, but in this case other influencing values make a mean one thus given not satisfactory. The P.-H. value is 1.769 × 10^7.

No attempt has yet been made in this investigation to evaluate R_H, but R_{inf} (line 11) reduced by $39\Delta_a \times 10^2$ gives the value 109677.7285. This is consistent with the scheme of affairs, but this R constant is not known experimentally in the third decimal place. 39 being, however, an *odd* number, is suggestive. Similarly, in the case of R_{He} the number 2912 gives the difference value giving R_{He} = 109722.1413, which agrees with the experimental value 1079722.14. This perhaps points to the truer value for Δ_H for H proper as being 0.365086 (see above). Ionisation enters into these matters. In the case of *β Lyræ* (Part VII) the whole numbers were *even*.

The He line λ 3203 may be closely evaluated thus:— $21\Delta_a \times 10^4$ = 3202.846626. Similarly, $3072\Delta_a \times 10^2$ = 4685.30706432. This line compared with the other 'first even' line of He when evaluated by taking $1792\Delta_a \times 10^2$ = 2733.09578752 gives a difference of 2733.09578752. This agreement seems to show that Δ_a is closely evaluated, and the calculations carried well into the decimal region were justified. It also shows that the displacement of the 'first lines' of each 'series' is a whole-number multiple of Δ_a. Further extensions are obvious. In these calculations Δ_a was taken as 0.0152516506.

In conclusion, it is evident that Δ_a is a *real* quantity confirmed by these studies.

$\Delta_a = \Delta_a$, this being a typographical variation.

PUNCTURE - SEALING COMPOUNDS FOR PNEUMATIC TYRES.

(*Washington Bureau of Standards.*)

ABSTRACT.

This article was written as an answer to the numerous requests which the bureau receives for information concerning various puncture-sealing compounds for pneumatic tyres. The different methods which are employed to render tyres "puncture proof" or self-sealing against punctures, are described and a discussion is given of the type which is the most common. Arguments for and against the use of such puncture-sealing compounds are given as well as answers to the usual questions which are asked concerning them.

The history of methods designed to prevent the escape of air from pneumatic tyres is almost as old as the pneumatic-tyre industry. Previous to the year 1900, when the bicycle was at the height of its popularity, at least eight patents had been issued covering way for making a pneumatic tyre "puncture proof." With the later development of the automobile tyre and continuing up of the present time it seems to be the goal of inventors to produce a "puncture-proof" tyre.

The use of the words "puncture proof" are in a way a misnomer, as the majority of the ways devised for puncture-proofing tyres are rather ways of sealing punctures and not preventing them. However, the words "puncture proof" are commonly used in connection with any means to prevent or to seal punctures. At least five different methods have been, or are being, used to accomplish these purposes.

During the last 30 years at least 65 patents have been granted for compounds to be placed in inner tubes to render them self-sealing when punctured. Although some few of these mixtures are soft plastic materials which contain rubber or rubber-like substances, by far the greater number of them are essentially suspensions of fibrous or flaky materials in water or an aqueous solution. Although the simplest are composed of only fibre and water, nearly all contain:

(1) A finely ground fibre; (2) water; (3) a material to aid in holding the fibres in

suspension; (4) a material to lower the freezing point of the liquid; (5) a preservative. In addition, dyes and odourous materials are often added to disguise the other ingredients.

The following solid materials arranged roughly in the order of their popularity have been used: Asbestos, mica, cork, wood fibre, paper pulp, bran, bark of special types, ground linseed, moss, leaves, grass, seeds, and oatmeal.

To aid in holding the fibres in suspension the following have been employed: Flour, starch, dextrin, gelatin, glue, sugar, glucose, caramel, gum arabic, soap, and water glass.

As materials designed to lower the freezing point, alcohol, glycerin, salt, and calcium chloride have been employed.

As preservatives, formaldehyde, carbolic acid, boric acid, chloroform, and certain asphaltic materials have been used.

In addition to patented products, there are many others, but all which the bureau has had occasion to classify fall under the foregoing general classification. Various proportions and combinations are used and in many cases other materials are added, as, for instance, whiting, clay, and graphite, which probably aid the fibre in the sealing process, and other organic liquids, such as "cactus sap," which may add desirable properties.

In using these compounds there must be enough to coat the inner surface of the tube with the fibrous or flaky material as well as a surplus to flow to the point where the puncture occurs.

Most persons are familiar with the old method of repairing a hole in a tea-kettle by inserting a small piece of cotton cloth. The sealing of an inner tube by these fibrous compounds works in a similar manner. An examination of a hole in a tube which has been sealed will show it filled with a plug of fibre which is not in any way cemented to the rubber. In other words, the fibrous mixture flows around inside the tube, and in case of a puncture the fibre is crowded into the opening by the pressure of the air in the tube. It is claimed for some compounds that they harden on coming in contact with the air. This hardening process takes place slowly and in the meantime the fibre alone must act as the seal. Punctures in the nature of a cut or tear are difficult or impossible to seal.

If a material consisting, for instance, of ground asbestos fibre and water glass, or leather fibre and gylcerin, is placed in an inner tube with a quantity of water and the tube is inflated in a casing, the puncture-sealing properties may be demonstrated in a very surprising way. A 6-penny nail can be driven through the casing, the tyre revolved so that the portion of the nail inside the casing becomes coated with fibre, and the nail removed without allowing an appreciable amount of air to escape. It is sometimes necessary to turn the tyre so that the puncture is on the downside in order that the surplus compound will cover it. If larger holes are made in the tube they may or may not seal, depending on their shape and size. Seals can often be obtained with a hole made by a 30-penny nail, but as a rule the compound cannot be depended upon to seal large holes.

The fact that the puncture-sealing properties can be shown in such a surprising way as by deliberately driving nails into tyres, has led to demonstrations of this kind being used very effectively in sales promotion. From the foregoing it will be apparent that such a demonstration proves very little concerning the value of any particular product as a tyre-sealing material, as the test can be duplicated with the simplest type of compound. Materials such as those described above are often used in boilers and heating systems to repair small leaks, and work very satisfactorily, where the parts are stationary. In a tyre, however, which is subject to continuous flexing while running, the question of a permanent seal is the important thing. In this respect some of the compounds are doubtless much superior to others.

Assuming that satisfactory puncture-sealing materials of the class mentioned can be obtained, the arguments which have been advanced for and against their use should be given consideration.

Arguments for their use:

(1) They will prevent delays due to punctures. (This refers only to relatively small punctures and not to large ones, cuts, blowouts, or "pinched" tubes.)

(2) They stop holes in porous tubes.

(3) They are said to prevent the escape of air through leaky valves. (This is open to question.)

(4) They keep the tyres cooler. (The use of a small amount of water in tyres, particularly truck tyres, to keep them cooler, has sometimes been advocated and a liquid puncture-sealing compound would act in the same way as water. It is questionable whether any great advantage would result.)

(5) They preserve the rubber. (Any appreciable effect is questionable.)

Arguments against their use:—

(1) It is not worth the cost and trouble because, with the good roads of to-day,

tyres receive comparatively few punctures of the class that would be sealed.

(2) In case of blowouts or large punctures they make considerable mess.

(3) They may freeze in winter. (This can be prevented by proper non-freezing agents.)

(4) They cause patches to loosen. (There is no reason for this with properly vulcanised patches. One maker states that "cold" cemented patches may loosen.)

(5) One maker of puncture-sealing material states that a tyre containing his compound should always be inflated with the valve at the top. This would apply as well to other compounds of the same type and if strictly adhered to would cause some inconvenience. (The reason for this precaution is probably to avoid the chance of any material being forced back through the valve.

(6) In case of a nail in a tyre, the motorist should know it and remove it before it damages the casing.

(7) At high speeds the wheel may be thrown off balance because of the bulk of the material being collected at one place.

REPORT OF H.M. INSPECTORS ON THE PROVISION OF INSTRUCTION IN PURE CHEMISTRY IN TECHNICAL COLLEGES AND SCHOOLS IN ENGLAND.

INTRODUCTORY.

This report deals with the amount and character of the instruction in classes in Pure Chemistry in Technical Colleges and Schools in England, which are in receipt of grant from the Board of Education. Though a considerable number of the students are attending classes in other subjects, such as Mathematics, Physics, Applied Chemistry, Botany, etc., these subjects are only referred to incidentally. Thus, the students may be attending courses leading to National Certificates awarded jointly by the Institute of Chemistry and the Board of Education, courses preparing for University Examinations, or for the Examinations of the Pharmaceutical Society, or courses bearing upon chemical or other industries, but it is only the instruction in Pure Chemistry in these courses which is under review. The information has been obtained, mainly, during the last two years, but the opinions are based upon a much longer experience of the classes covered by the report.

VOLUME AND CHARACTER OF THE WORK.

The provision of instruction consists of full-time courses, and part-time courses which are held in the evening and less frequently in the daytime. There are also isolated and independent classes in Chemistry in some of the smaller schools. The part-time courses normally involve attendance for three nights a week; and both full- and part-time courses are generally designed for some specific purpose, such as a general training in Chemistry, training for some branch of chemical industry, the provision of chemical instruction for students who are engaged in other industries, or preparation for a professional examination.

In the table given below an attempt has been made to indicate for 163 schools and colleges not only the total volume of work in these institutions, but the distribution of the students over courses with different objects. The figures are only approximate because the courses are seldom entirely separate, and it is not always easy to determine to which category a student belongs; but they show in a general way the number of students and their distribution over the different courses.

FULL-TIME COURSES.

	No. of Centres	No. of Students receiving instruction in Pure Chemistry. Course	Non-Course.
(a) In courses similar in type to National Certificate courses	7	47	12
(b) In University courses	18	541	3
(c) In Applied Chemistry courses	11	96	4
(d) In Pharmaceutical courses	14	276	—
(e) In other courses, such as Engineering, Mining, Building, etc.	29	625	—
(f) In training in research	7	36	5
		1,621	24

PART-TIME COURSES.

	No. of Centres	No. of Students receiving instruction in Pure Chemistry. Course	Non-Course.
(a) In National Certificate courses	32	1,516	364
(b) In similar courses not recognised for National Certificates	48	815	328
(c) In University courses (including Matriculation	99	1,608	427
(d) In Applied Chemistry courses	47	1,177	112
(e) In Pharmaceutical courses	101	2,183	163
(f) In other courses, such as Engineering, Mining, Building, etc	69	966	120
(g) In training in research	7	71	83
		8,336	1,547

Of the 11,000 students under instruction about 15 per cent. are in full-time attendance at 32 institutions. Thirteen of these institutions are in northern countries, eight are in the midlands, seven are in the metropolitan area, and four in the south-eastern counties. University and other courses are fairly evenly distributed over the country, and Pharmaceutical courses are more prevalent in the midlands than elsewhere. The bulk of the full-time instruction in Pure and Applied Chemistry ,however, is given in the Universities and University Colleges, which are outside the scope of this report.

Of the 163 institutions providing instruction in part-time grouped courses, 53 are in the northern counties, 53 in the midlands, 16 in the metropolitan area, 12 in the eastern counties, 23 in the south-eastern counties, and 6 in the south-west. National Certificate courses are more numerous in Lancashire than in any other part of the country. All the schools ,except a few of the larger ones in this area ,work under the scheme of the Union of Lancashire and Cheshire Institutes, and as the examinations of this Body are approved for the purposes of National Certificates, there is more uniformity in the content and purpose of the instruction than in other parts of the country. A similar effect is to be observed in London, where the students in University courses are more than twice as numerous as those in any other course. The University and National Certificate courses are, in the majority of cases, courses in pure science. In the former the time is about equally distributed between Mathematics, Physics, and Chemistry; in the latter more time is given to Chemistry. Where the University Course proceeds beyond Intermediate Science standard, it is sometimes recognised for National Certificates, and conversely, students often prepare for University examinations in courses which may or may not be recognised for National Certificates. The courses described as similar to National Certificate courses include courses which are not sufficiently comprehensive or advanced to be recognised, or courses in respect of which no application for recognition has been made.

The courses in Applied Chemistry are, as might be expected, more numerous in the midlands and the north than elsewhere. They are, however, provided in seven centres in London. In the eastern counties there are only two, and in the south-east none.

The special courses in Pharmacy have developed very considerably in recent years, and a large number of students are now attending part-time day classes. Of over 2,000 students taking a course in 1925-26, 591 were in the north and north-eastern counties, 241 in the north-western counties, 579 in the west-central and east-central counties, 117 in the eastern counties, 260 in the south-eastern counties. Except when the classes are held in the daytime these students almost invariably attend the same classes in Chemistry as other students.

Part-time courses for students in Engineering, Mining, Building, etc., in which Chemistry is a constituent subject are relatively less numerous than similar full-time courses, because the limited time which can be devoted to study requires concentration upon subjects which bear most closely upon the students' occupations. They are three times as numerous in the midlands as in any other part of the country.

,Though the number of schools in which Chemistry is taught as an isolated subject is much less than it was, there are still between forty and fifty centres of this type with between 600 and 700 students in attendance. They are usually found in small towns, and their students are very varied in attainment and purpose.

AGES OF STUDENTS.

Of the students attending full-time courses rather more than 70 per cent. are under 21 years of age. In part-time courses the percentage of students under 21 is just a trifle higher, being nearly 72 per cent. As a rule the minimum age of admission to both full- and part-time courses is 16. Since only a limited number of schools provide a course of longer duration than three years, a preponderance of younger students is to be expected. But it is obvious from these figures that a number of students are either entering late or spending more than the minimum number of years required to complete the course. Observation shows that both of these factors exist.

PRELIMINARY EDUCATION OF STUDENTS.

For admission to a full-time course a student is expected to have received a secondary school education, though he need not have matriculated. For admission to a part-time course a student who has not been to a secondary school is expected to have passed through a junior technical course consisting of Mathematics, Science, Drawing, and English ,or to show that he he has some knowledge of these subjects. Though no statistics have been obtained, it is certain that a large and increasing proportion of th students have been to a secondary school or some other type of full-time school which provides education of a higher standard than that attained in public elementary schools. This improvement has been encouraged not only by the wider provision of secondary and central schools, but also by the growing practice of employers in requiring that candidates for junior positions in their laboratories shall have received a superior type of education. In some towns, too, the evening junior technical courses are very well organised, and Principals of schools in these towns are able to insist upon an adequate standard of preliminary training as a condition of admission. As a consequence, a higher standard of attainment is now secured ni respect of an increasing number of part-time students.

(To be Continued.)

INSULIN AND ITS MANUFACTURE.

By F. H. CARR, F.I.C.
(President of the Society of Chemical Industry.)
(Before the Royal Society of Arts, February 23, 1927.)

The discovery of insulin has beld the imagination of the general public in a greater degree than perhaps any other discovery in pharmacology and chemistry. It is a tribute to the keen interest that is taken in scientific advances which promise relief to suffering humanity that you should come here to-night to listen to an address on technical aspects of this subject.

At this distance of time, five years after the event, it is possible to appraise with some accuracy the value of the work of Banting and Best in discovering insulin. Time has not only justified the dramatic reception accorded to it but has proved the utility of insulin to be perhaps even greater than was anticipated, both in the relief of suffering and in opening out the avenues to new knowledge.

The time has passed when it was novel to regard the living body as the source of therapeutic substances, and there are now a number of natural remedies produced within the animal which are utilised as external agents to supplement and reinforce the activity of the body. Insulin was not, of course, the first of these; adrenalin and thyroxine are examples of substances possessing remarkable potency which had previously been isolated from the animal body in a pure crystalline form.

It was seven years after the physiological importance of the secretion of the suprarenal gland had been first realised that the active principle was isolated as the result of much experimental work. Three years later its chemical constitution was known, and four years after that there had been made artificially adrenalin which was quite indistinguishable from the natural product.

Such is a typical record of scientific achievement. To-day our knowledge in regard to insulin has only proceeded to the point at which we are able to prepare it in a purified form from natural sources. The physiologist has discovered much about its properties, but the chemist has learnt but little of its nature.

Perhaps I may be allowed to refer briefly to one other example of progress in this field. During the past year, Dr. C. R. Harington, a young English chemist, has succeeded not only in determining the structure of thyroxine—the active principle secreted by the thyroid gland—but has

crowned this achievement by building it up in the laboratory from very simple chemical substances.

Thyroxine, like insulin, is produced within the healthy animal, but a lack of it causes well recognised symptoms of disease, which can he removed with dramatic success by the administration of thyroxine. In a normal individual the oxidative metabolism of the body is fundamentally controlled by the continual release of thyroxine from this gland in quantity which must be very minute, for as little as ten milligrams of it injected into a normal individual increases the rate of metabolism to 45 per cent. above the normal—an effect which does not completely subside until a fortnight after the injection.

Adrenalin, the active principle of the suprarenal gland, has a chemical constitution not unrelated to that now found to represent thyroxine, the active principle of the thyroid gland.

Thanks to Harington, then, we have a thoroughly chemical understanding of these substances. As already explained, our knowledge of insulin has not yet advanced to that point, and we know very little of its chemical character. Our information as to its properties has resulted chiefly from the study of the effects produced when it is injected into the blood stream of a living animal. When so injected it causes the removal of sugar. As to what happens to that sngar we shall learn more presently. When added to sugar in a test-tube it effects no change.

Physiologists have led us to regard the human body as an engine which derives its heat and muscle energy for the most part from glucose during its oxidation in the tissues. The alimentary canal functions by partially rendering the useful constituents of our diet soluble or capable of emulsification so that they may pass into the interior, the intestine being regarded in this sense as exterior. Those constituents which pass thus to the interior are in a large proportion converted to sugar.

Our food consists as to 60 per cent. of carbohydrate, which is converted by the body into sugar; also the remaining 40 per cent. of the diet is largel yconverted into sugar by the body activities, so that by far the greater part of our food is utilised in the form of sugar. The chief sugar occurring in blood is glucose; the other assimilable mono-saccharides, mannose, galactose and fructose, are converted into it before utilisation, probably being first built into glycogen and then broken down into glucose. A few hours after the taking of food the percentage of sugar in the blood of a healthy individual becomes constant at about 0.1 per cent., but when a meal is given it may rise in about 30-40 minutes to 0.15 per cent. In the course of one or two hours it will again return to normal.

Long before the discovery of insulin, experiment had shown that, if the pancreas be removed from an animal, the body loses control so to speak of its sugar, and the percentage in the blood and tissues increases until the whole body is flooded with sugar. This naturally causes serious disturbances to the general health, and this is the condition present in diabetes. When the blood sugar reaches about 0.18 per cent., sugar begins to overflow into the urine.

Such observations led scientific workers to regard the pancreas as the probable source of a substance which controls the amount of sugar in the blood stream. Time does not permit me to deal at length with the history of the researches which after many years led to the isolation of insulin by Banting and Best in 1922. Suffice it here to say that these workers were the first to isolate from the pancreas a stable substance which had these properties in an extraordinarily high degree. They would be the first to recognise that their achievement was rendered possible by the work of their predecessors.

Now the pancreas has another well-known function, namely that of secreting *digestive enzymes, including a proteolytic* ferment. This ferment passes from the pancreas by a duct into the alimentary canal. Insnlin, on the other hand, does not pass down this duct but finds its way from the ancreas to the blood stream internally without being ejected externally down a duct.

It may be regarded as an unlucky juxtaposition that insnlin and these digestive secretions should occur in close proximity in the pancreas. Unlucky, because the chemical nature of insulin is such that it is rapidly destroyed by these very digestive substances. It was mainly due to this fact that previous investigators had failed to isolate insulin; this was the difficulty which Banting and Best overcame with so great success.

Their method of investigating the problem was to inject extracts of pancreas into living animals and to determine the effect upon the sugar content of the blood. For this they required to use living animals, for insulin does not produce its effects in blood which has been removed from an animal.

They required, too, delicate methods of determining minute amounts of sugar in blood. These had been recently evolved by biochemists, and the work of Banting and Best was in no small measure dependent upon these delicate methods of analysis which others had elaborated before them.

It had been shown that the foetal pancreas does not up to the fourth month of development secrete an active proteolytic ferment, or trypsin, as it is called, and Banting and Best found that an extract of foetal pancreas, though free from trypsin, had a powerful effect in reducing the blood sugar. This gave them the key to unlock the secret which had for so long baffled experimenters. They set out to devise methods of extracting the pancreas which would give an extract rich in insulin and poor in trypsinogen. As trypsinogen is insoluble in strong alcohol, they employed this solvent and soon arrived at a method of preparing a fairly stable and very active extract. There remained the problem of purifying this extract and perfecting the method of preparation so that the destructive action of the enzymes might be entirely eliminated, and in this success was ultimately achieved.

Among those taking part in this work whose names should especially be mentioned are Collip, Doisy, Somogyi and Shaffer, and Dudley.

Insulin then is a substance prepared from the pancreas. It can be purified and obtained as a solid substance. I will not enter into details of the methods of purification, but will content myself with summarising the characteristics of insulin on which these methods depend.

Properties of Insulin on which Methods of Purification Depend.

Destroyed by N/10 sodium hydroxide at 37° in 1½ hours.
Destroyed by N/10 sodium carbonate at 100° in ten minutes.
Destroyed in neutral solution at 100° in 1 hour.
Not completely destroyed by N/10 acid at 100° in 1 hour.
Destroyed by proteolytic enzymes.
Destroyed by formaldehyde.
Soluble in water except at $pH = 5$.
Soluble in 90 per cent. phenol.
Soluble in 60 per cent. alcohol.
Insoluble in absolute alcohol.
Insoluble in ether.
Insoluble in acetone.
Insoluble in glacial acetic acid.
Precipitated by sodium chloride.
Precipitated by ammonium sulphate.
Precipitated by sodium oxalate.
Precipitated by picric acid.
Precipitated by trichloracetic acid.
Precipitated by naphthol yellow S.
Readily adsorbed at pH 5 on to charcoal and kieselguhr.

The most characteristic property which is used for separating it from accompanying impurities is precipitation by exactly adjusting the acidity of the solution to a point in the neighbourhood of pH 5. By reason of their amino groups polypeptides are alkaline and by reason of their carboxyl groups they are acid. There is a point in the process of neutralisation when neither the amino group nor the carboxyl group is bound by acid or alkali respectively. This is the iso-electric point and may be represented thus :—

$$M\left\langle\begin{matrix}NH_2\\ COONa\end{matrix}\right. \longleftarrow M\left\langle\begin{matrix}NH_2\\ COOH\end{matrix}\right. \longrightarrow M\left\langle\begin{matrix}NH_3Cl\\ COOH\end{matrix}\right.$$

By precipitating with absolute alcohol and then re-precipitating from dilute solution with picric acid and finally taking advantage of this iso-electric precipitation, repeating the process if necessary, a white powder may be obtained which has an activity such that a unit is represented by 1/20 mg. Abel has, however, carried the purification further by precipitating with pyridine from acetic acid solution, and he claims to have produced a substance of which 1/100 mg. represents a unit. Moreover, his product was a crystalline substance melting at 233° C.

Purification cannot be carried out by Abel's process without considerable loss, and for every gram of Abel's material probably one ton of pancreas would be required; consequently questions of expense are apt to deter those wishing to repeat his work on a larger scale. Abel's insulin still gives the Biuret, Millon, Pauly and Ninhydrin reactions.

If we base our opinion of the chemical character of insulin upon this evidence, we must class insulin as a proteose or polypeptide. Polypeptides differ chemically in the number of different amino nuclei they contain, and on his showing insulin is a complex one. Others claim to have produced insulin which gives negative reactions for tryptophane and tyrosine.

Casimir Funk has purified insulin by forming a compound with naphthol yellow S, and he claims thus to have prepared a substance of constant composition to which

he assigns the formula $C_{69}H_{102}O_{22}N_{18}S$. He considers that it is a polypeptide in which fifteen amino acids are coupled. One hesitates to accept these remarkable conclusions without more detailed information than has hitherto been provided as to the experimental evidence on which they are based

Abel has observed that with increasing purification there is an increase in the sulphur content of insulin, and he says that that portion of the sulphur which is easily split off is an index of the physiologically active hormone present in impure insulin. He takes the view that sulphur is an integral constituent of the molecule. There is one well-known amino acid of the body which contains sulphur; this is cystine, a substance readily obtained from hair or wool. Will the insulin molecule be found to possess similar grouping? Cystine is represented by the following formula :—

CH_2 . S	.	S .	CH_2
$CHNH_2$			$CHNH_2$
COOH			COOH

Our knowledge of its chemical characteristics being so small and uncertain, let us consider a little more in detail the effect which insulin produces in the living animal. We have already seen that within the body much of the food is converted to glucose. Although this glucose passes into the blood stream, the level of sugar in the blood is constant except immediately after a meal. The sugar is laid down or stored in the liver and muscles as glycogen, and this process of storing takes place under the influence of insulin. This store of glycogen provides the source from which the blood continually derives sugar to maintain the normal level below which health suffers. If the percentage of sugar in the blood falls to the minimum, serious symptoms result. The condition when the percentage of sugar is below normal is known as hypoglycaemia. When the blood sugar reaches 0.18, the kidneys, which otherwise do not allow sugar to pass, can no longer prevent it overflowing, and so sugar is excreted in the urine as in the case of diabetes.

Under normal conditions the body produces insulin in the pancreas and stores it, and there is continually discharged into the blood stream that amount of insulin which maintains the blood sugar at the usual level. By some wonderful adjustment the supply of insulin is increased when the blood sugar rises above and cut off when it falls below normal. In a person suffering from diabetes the supply of insulin fails, either from lack of insulin or from a defect in this process of releasing it.

It is only within the past year that by a clever and interesting piece of work by Best, Dale, Hoet and Marks it has been shown what happens to the sugar when it disappears from the blood under the influence of insulin.

The sugar is not entirely used up, since the increase in the amount of carbon dioxide given off by the body or of oxygen taken up by it is not sufficient to account for all the sugar which disappears. Where then does it go?

Best, Dale, Hoet and Marks showed that the loss of sugar is completely accounted for by conversion into glycogen and by combustion. In a series of experiments which called for the highest skill and ingenuity, they were able to construct a balance sheet based on actual chemical analysis which accounted for the whole of the sugar passed into the animal together with that originally present before the administration of insulin.

WEIGHT OF SUGAR.

	Before insulin grams	After insulin grams	loss grams
Liver	3.124	2.252	0.872
Muscle	4.48	3.36	1.12
Sugar injected			1.68
			3.672
Blood sugar ...	.630	.060	0.570
Total			4.242

CALCULATED AS SUGAR.

	Before insulin grams	After insulin grams	Increase grams
Muscle-glycogen	10.178	11.186	1.008
Sugar equivalent of oxygen absorbed		3.079	3.079
Total			4.087

(*To be Continued.*)

X-RAY ISOCHROMATS OF COPPER TAKEN IN DIFFERENT DIRECTIONS RELATIVE TO THE CATHODE STREAM.

By WARREN W. NICHOLAS.

Abstracted from the *Physical Review*.)

Variation with potential of the intensity of monochromatic X-rays of wave-lengths 0.823 to 0.247A for directions making angles of 36°, 90° and 144° with the cathode stream. X-ray isochromats of copper were taken in three different directions relative to the cathode stream, for a target face making an angle of 25° with the cathode stream. Corrections were made for stray radiation in the neighbourhood of the measured beam, for radiation due to secondary hits of cathode electrons which had been reflected backward from the focal spot at large angles, and for absorption in the target. It is established that, within experimental error, an isochromat of frequency ν varies linearly with the potential from potentials about $(5/4)$ $H\nu$ to $2H\nu$, where $H\nu$ is the quantum voltage for excitation of frequency ν. The linear portions of the graphs were extrapolated to find the intercept on the intensity axis at $H\nu$. This intercept depended on $H\nu$, and also on θ, the angle between the measured X-rays and the cathode stream. For $\theta = 90°$ the intercepts varied between 0.062 I' (for $H\nu$ = 50 kv.) and 0.085 I' (for $H\nu$ = 15 kv.) with an average of 0.072 I'; for $\theta = 36°$ the respective values were 0.076 I', 0.096 I', 0.086 I'; for $\theta = 144°$, 0.035 I', 0.010 I', 0.017 I'. I' is the intensity of the isochromat at $2H\nu$. Values of $H\nu$ used were 15, 20, 30, 40 ,50 kv. The intercept decreased ,in general, for increasing $H\nu$, but for $\theta = 36°$ and $\theta = 90°$ the change was within the experimental error of ± 0.01 I'.

Energy distribution in the X-ray continuous spectrum from a thick target.—Kulenkampff's formula for the energy distribution in the X-ray continuous spectrum for $\theta = 90°$ does not hold in detail for the higher voltages and different target face inclination used in the present work. Assuming total energy in the continnous spectrum proportional to the square of the voltage on the tube, and assuming suitable modifications of this law, for the forward and backward angles, from Sommerfeld's space distribution of energy as a function of cathode ray velocity, it is shown that the spectrum for the forward angle contains relatively more high frequency rays than the spectrum at 90°, and the spectrum at the backward angle contains relatively more low frequency rays.

Energy distribution in the X-ray continuous spectrum from a thin target.—On similar assumptions as to total energy, the spectra which would have been obtained from a very thin foil of copper are derived from the isochromats by Webster's method. The thin target spectra on a frequency scale, for $\theta = 90°$, are horizontal except for a sharp rise in intensity as ν approaches ν_0, the high frequency limit. For $\theta = 36°$ the energy is approximately directly proportional to ν except for the region near ν_0, where there is again the sharp increase. For $\theta = 144°$ the energy is approximately inversely proportional to ν except near ν_0 where there is a decrease for high voltages.

Theories by Kramers and Wentzel for $\theta = 90°$ are in fair agreement with the experiments as to thick target spectra, but if certain assumptions made in this paper are correct, Kramer's predicted thin target spectra are much more nearly in accord with the facts than are Wentzel's.

General Notes.

SAFEGUARDING OF KEY INDUSTRIES.

The Board of Trade give notice that the Treasury, by order dated 23 June, have exempted under the provisions of Section 10(5) of the Finance Act, 1926, for the period from 27 June, 1927, to 6 March, 1928, the following articles from the duty imposed by Section 1 of the Safeguarding of Industries Act, 1921, as amended by the Finance Act, 1926 :—

Ammonium perchlorate; Dial (acid diallyl barbituric); Elbon (cinnamoyl para oxyphenyl urea); Hydroquinone; Integrators (planimeter type); R Lead acetate; Lipoiodin; Phytin; Planimeters; Potassium guaiacol sulphonate (thiocol); Urea (carbamide).

ONTARIO HYDRO-ELECTRIC COMMISSION PLANS EXPANSION OF NIPIGON POWER DEVELOPMENTS.

Engineering plans are now being put into effect by the Hydro-electric Power Commission of Ontario whereby the water-powers of the Nipigon River will he developed to their full capacity of 260,000 horse-power in a comparatively short time. At present the Cameron Falls station has a capacity of 75,000 horse-power and is feeding the

Thunder Bay transmission system, which is supplying a rapidly growing market for power at Fort William and Port Arthur. A short distance below Cameron Falls, construction is under way on a 55,000 horse-power development at Alexander Landing and the new plans include the development of 100,000 horse-power at the Virgin Falls and Portage Landing sites.

A $42,000,000 JUMP IN CANADA'S NON-METALLIC MINERAL PRODUCTS.

Canada's manufactures of non -metallic mineral products in 1926 amounted in value to $186,261,756, an increase of 42 million dollars over the corresponding figure for 1925 and the highest on record for this group of industries.

CHEMICAL INDUSTRIES.

Industries of the Niagara Peninsula.

Many industries have been established in the Niagara Peninsula because of the inherent advantages of the locality. The *chemical industries naturally fall into two* groups, those which consume electric energy for power purposes only, and those which are directly dependent upon electric power for the operation of their processes (electro-chemical).

The first of these groups includes many minor industries employing chemical processes for the manufacture of textile cleansers and softeners, dressing creams, cleaning soaps, polishes, fireworks, baking powders, and similar products, to which no further reference need be made. Only the major *important industries of this group which* are established in this district are briefly described.

Heavy acids of all strengths (sulphuric, hydrochloric ,and nitric) are manufactured at Hamilton, Ontario, by the Grasselli Chemical Company, imported sulphur and nitre being used. This firm also makes *acetic acid, Glauber's salt, and calcined salt* cake. The plant is equipped with pyrites burners for the production of the sulphur dioxide used in their process, these units being employed in lieu of the sulphur burners *when market conditions warrant* their use.

Pulp and paper from coniferous woods are made by two firms. The Lincoln Pulp and Paper Company operating at Merritton, on the Welland Canal, makes unbleached and bleached sulphite fibre, from which they manufacture book and wrapping papers. The Ontario Pulp Company owns a large plant at Thorold, Ontario, engaged in the production of groundwood pulp and unbleached sulphite fibre, from which newsprint and wrapping papers are produced.

Soaps (textile, dressing, laundry, domestic, toilet) are manufactured at Hamilton by the Proctor and Gamble Company, of Canada. By-product glycerine from the soap plant passes to a refining department for treatment. This firm also operates a hydrogenation plant for the production of domestic shortenings from vegetable oils. This operation includes the production of oxygen gas. Most of the chemicals used in the processes are purchased from outside sources.

Paints, varnishes, lacquers, driers, stains and allied products are made at Bridgeburg, Ontario, by Pratt and Lambert, Incorporated. The raw materials are all imported.

Coal, gas and coke for domestic and industrial purposes are manufactures by the Hamilton B-Product Coke Ovens, Limited, and by the United Gas and Fuel Company, at Hamilton. The first-named Company operates a battery of 60 Semet-Solvay standard horizontal flued type ovens; the plant is of very modern design, has a carbonising capacity of about 1,200 tons of coal per 24 hours, and is very flexible; by-product ammonia and crude naphthalene are recovered. The second-named Company only carbonises about 5,000 tons of coal per annum, the gas being used to supplement the City supply derived from other sources; by-product ammonia is recovered. Both plants also recover the tar which is delivered by pipe line to the refining plant of the Hamilton Tar Products Company. Coke for metallurgical and domestic purposes and gas for use in the steel plant is made by the Steel Company of Canada in their Hamilton plant. The installation includes 80 Wilputte by-product ovens, having an annual output capacity of about 365,000 net tons of coke. The annual by-product recovery plant includes a benzol refinery having an annual capacity of over two million gallons of light oils; the final products of this refinery include several grades of naphtha, benzol, toluol and xylol. By-product ammonia is recovered as ammonium sulphate. A portion of the tar is used in the open hearth furnaces for fuel; the balance is sold to the Hamilton Tar Products Company.

Coal tar distillation is carried on in Hamilton at the one plant already mentioned, which receives tars from three sources. The principal products of this plant are naphtha oil, creosote oil, naphthalene, tars and pitches; the company also manufactures tarred felts, tarred sheathings, coal tar paints, road surfacing products, and disinfectants.

Portland cement is manufactured by the Canada Cement Company at a plant in Port Colborne ,on the Welland Canal, at the Lake Erie entrance. Particular interest attaches to this plant because a potash recovery unit, using a spray system, was installed here just at the end pf the war; after experimental operations for some months, it was closed down and has not since been re-opened.

Lime is made from local limestones in two plants near Hamilton by the Hamilton Lime and Cement Works and hy the Gallagher Lime and Stone Company. Both plants use gas fired kilns, and the last named firm also produce hydrated lime.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read at the meeting held on June 23 :—

The Absorption of Slow Cathode Rays in Various Gases. By J. F. Lehmann. Communicated by Sir Ernest Rutherford, P.R.S.

A homogeneous beam of electrons of definite initial energy was intrornced into an ionisation chamber. The ratio of the positive ion current due to the asorption of these electrons, to the incoming electron current, gave the average ionisation per electron. At low gas pressures the ionisation per electron was proportional to the pressure, at higher pressures, adequate to completely absorb the electron beam before it reached the walls of the ionisation chamber, the ionisation per electron was independent of pressure. The transition between the two pressure ranges was abrupt and determined a critical pressure just adequate to absorb the electron beam. The magnitude of the critical pressure was determined by the initial energy of the beam and the gas used to absorb the electrons.

For complete absorption of the electron heam the average ionisation per electron was directly proportional to the energy of the electrons, the constant of proportionality varying markedly from gas to gas. The ratio

$$\frac{\text{initial energy of eleetron}}{\text{average ionisation per electron for complete absorption}}$$

determined the average energy expenditure associated with the formation of a pair of ions. This was found to range from 31 electron-volts per ion pair in helium to 45 electron-volts per ion pair in air, nitrogen and CO_2. The efficiency of ionisation as defined by the ratio

$$\frac{\text{ionisation potential}}{\text{average energy expended per ion pair}}$$

was found to be, in helium 0.78, argon 0.46, hydrogen 0.43, nitrogen 0.38, and carbon dioxide 0.32.

It is evident that much of the initial euergy of the electron was expended by processes other than separating the molecule into positive and negative ion. In the case of helium, the experimental results are in good agreement with Mr. R. H. Fowler's views on ionisation by collision. He estimated that a quarter of the initial energy of the primary ionising electrons should ultimately be distributed among the primary and the secondary or ejected electrons as residual kinetic energy inadequate to cause further ionisation. In the other gases it seems probable that excitation and dissociation may absorb much of the initial electronic energy, but data available concerning these processes are inadequate to allow a precise estimate of energy so dissipated.

A Simple Radio-Active Method for the Photographic Measurements of the Integrated Intensity of X-ray Spectra. By W. T. Astbury. Communicated by Sir William Bragg, F.R.S.

(1) A simple photometric arrangement is described in which the negative is replaced by a carbon print and the measurements are carried out by means of α-rays and an α-ray electroscope. This radio-activity photometer has been applied to the investigation of the intensity distribution in X-ray crystal photographs.

(2) As a preliminary test the apparatus was used to find the intensity ratio, $CuK\alpha/K\beta$. In X-ray photographs of the (muscovite) mica cleavage plane it was

found that, 1st order : 2nd order : 3rd order = 66 : 31 : 100, and that the intensity ratio $CuK\alpha / K\beta$ is 6. , when corrected for the *absorption* of the window of the X-ray tube.

(3) A further test with a double-wedge photograph of the 3rd order $K\alpha$ mica line gave still more satisfactory intensity values for the seven steps of the wedge.

(4) It is shown how the apparatus may be made to give a curve showing a relation between X-ray intensity and α-ray intensity which is very approximately linear through the origin.

(5) The application of this property to the determination of the integrated intensity of $\frac{1}{2}$-ray spectra is discussed and a method outlined.

(6) The method of preparation of the carbon prints for the radio-activity photometer is described.

SOCIETY OF GLASS TECHNOLOGY.

The one-hundredth meeting of the Society of Glass Technology was held in Sheffield on Wednesday, June 15, 1927, the President, Mr. Walter Butterworth, Sen., M.A., in the chair. Sir W. H. Hadow, C.B.E., D.Mus., LL.D., Vice-Chancellor of the University of Sheffield, was present and congratulated the Society on reaching its one-hundredth meeting.

The following paper was read :—

Gaseous Fuels for Furnace Heating. By R. WIGGINGTON, B.Sc.

The chief gaseous fuel is producer gas, made by the partial combnstion of coal (or coke) in an air-steam blast. Considerable variation in composition may be obtained by modifying the ratio of air to steam. Increasing the steam causes the partial replacement of carbon monoxide by hydrogen, and of nitrogen by carbon dioxide. A moderate use of steam improves the gas, but a further increase is disadvantageous. In a bunsen flame, the flame speed determines the back-firing tendency, and the height of the inner cone. Hydrogen will thus give a shorter flame than carbon monoxide or methane.

In a non-ærated jet flame, on the other hand, the flame length depends chiefly on the air requirement. Hydrogen and carbon monoxide, each needing $2\frac{1}{2}$ times their own volume of air, will have a flame 4 times as long as either. Reduction of the oxygen in the atmosphere will cause a lengthening of the flame, which will finally leave the burner top and float just before extinction.

The flame in a furnace may be regarded as a jet flame modified by turbulence to something approaching a bunsen flame. Hydrogen will still give a shorter flame than carbon monoxide in such circumstances. A long flame is generally preferred, to give uniform heating.

Hydrogen more than other gases is liable to undergo flameless catalytic "surface combustion" in contact with red-hot brickwork. This (in an ordinary furnace) is undesirable as it leads to non-uniform heating and greater wear and tear of the refractories.

Gas rich in carbon monoxide is to be preferred on account of its longer flame, greater radiating power, and smaller liability to surface combustion. Uniformity in the gas (or at all events, absence of accidental variations) is obviously also very desirable, apart from the actual composition. These ends can only be secured by proper control over the blast saturation temperature of the producer; a thermometer in the blast pipe, or some more elaborate equivalent, is essential. Some form of positive blower is much easier to control than the usual steam jet. Sufficient steam to minimise clinker trouble must be used.

MINERALOGICAL SOCIETY.

The following papers were read at the meeting held on June 14, Prof. W. W. Watts, F.R.S., President, in the chair :—

On the Atomic Volume Relations in Certain Isomorphous Series. By A. F. HALLIMOND.

The paper is based on accurate data made available by the researches of Dr. Tutton and other workers. For isomorphous salts of the entropic elements K, Rb, Cs, the differences Cs, K, and Rb-K stand in constant ratio, and the same ratio holds good for the free metals though these are considerably larger than in the combined state; the constancy does not extend to the salts of NH_4 or Tl. A modified additive relation is indicated, the volumes of the metals when free and when combined being in the same ratio as the differences for the free metals and for the respective isomorphous series. In the same way volumes can be calculated for combined Na and Li from those from the free metals. Salts of Cl, Br and I exhibit a similar constancy in the ratio of their differences, and this would appear to be a distinctive character of each 'eutropic' group of elements. Volumes are calculated for combined Cl, Br. I. These and the other values for the acid radicles in the above

series are in very close agreement with existing knowledge of the size of the atoms, a fact which affords strong confirmation of the validity of the method now proposed for computing the volume of the elements in the combined state.

Petrology of the Bodmin Moor Granite (Eastern Part), Cornwall. By DR. P. K. GHOSH.

Three types of granite are mapped and described in detail: (1) an earlier coarse-grained 'normal granite,' followed by (2) a coarse-grained granite of Godaver type, and (3) a fine-grained granite. Various minor intrusions connected with these are described and also their altered facias. Several types of hornfelsed inclusions of sedimentary rocks are distinguished. Eight detailed chemical analyses are given of the rocks.

On the Distribution of Purple Zircon in British Sedimentary Rocks. By PROF. P. G. H. BOSWELL.

The properties and behaviour under radioactive treatment of purple zircon from sedimentary rocks are described. The distribution of the mineral in British sedimentary rocks is considered in some detail, for it occurs at practically every horizon. In the Carboniferous, Permian, Triassic and Aptian rocks, it is especially abundant and is there associated with numerous other minerals apparently freshly-derived from crystalline metamorphic rocks.

On β-Quartz Twins from Cornwall. By DR. J. DRUGMAN.

β-Quartz seems to be sufficiently differentiated from α- or low-temperature quartz for the two to be treated quite apart from each other. This is specially the case with the twin-laws one observes in these. In β-quartz, twinning with inclined axes is a very common occurrence indeed and examples are very abundant in the Cornish localities visited by the writer, namely, Belowda Beacon, a china-clay pit near Belowda Beacon and Wheal Coates. Besides twinning on ($10\bar{1}1$), Esterel twinning, and twinning on ($11\bar{2}2$) three new laws were found by the author, namely, twinning on ($30\bar{3}2$), confirmed by a good Estérel specimens; twinning on ($20\bar{2}1$) (and perhaps on the Zinnwald law) and lastly twinning on ($21\bar{3}2$), also confirmed by an Estérel speci-

The Separation of Manganese in Rock Analysis. By E. V. HOLT AND DR. H. F. HARWOOD.

In carrying out the exact analysis of rocks the whole of the manganese they contain can be completely precipitated with alumina and ferric oxide by employing the following procedure:— The solution after removal of silica is diluted to 400 cc., heated to boiling after the addition of ammonium chloride, and ammonia added to alkalinity. Bromine water is then run in slowly from a tap funnel whose stem is drawn out to a fine jet, small additional quantities of ammonia being simultaneously added to keep the solution alkaline. When the addition of the bromine is complete the liquid is boiled for one minute, and then filtered. The precipitate is redissolved and the the precipitation repeated; in the combined filtrates lime and magnesia are determined by the usual methods. The results are perfectly satisfactory up to a limit of 50 milligrams MnO; when more than that quantity is present some lime and magnesia are liable to be carried down with the alumina precipitate, but such a case will practically never occur in rock analysis.

Corundum Twins from Transvaal. By DR. L. J. SPENCER.

Large twinned crystals of corundum, up to 6 inches across but only about an eighth of an inch thick, are abundant in plumasite rock near Bandolier Kop, northern Transvaal. The twin-plane is a face of the primary rhombohedron and the twinned crstals have a form resembling arrow-heads.

CORRESPONDENCE.

EXAMINATION QUESTIONS.

(To the Editor of THE CHEMICAL NEWS.)

Sir,

The General Elementary Science Paper set in the present General Schools Examination of the University of London contains a question that must have puzzled some of the candidates and is worthy of mention although it does not exactly fall into the category of unfair questions which were alluded to in Mr. Price's letter in your issue for May 27 (Vol. CXXXIV, p. 334).

We refer to Question 5 of the Physics Section, which reads:

> "You are provided with a thin convex lens of local length 4 ins.; determine by a scale drawing and also by calculation the size and position of an object 1 in. high placed 12 ins. in front of the lens."

As it stands, the answer is:— "The size and position of the object is 1 in., and 12 ins. in front of the lens." It is, however, difficult to see how this may be "calculated."

What the examined (a lady, by the way), intended, we presume, was that the candidates should calculate the size and position of the *image* of the object. This is, however, not stated in the question, which, as it stands, seems absurd to us.

We are,
Yours, etc.,
J. G. F. DRUCE,
E. J. WEEKS.

Battersea Grammar School,
S.W.11.
June 27, 1927.

INTERFERENCE PHENOMENA.

(*To the Editor of* THE CHEMICAL NEWS.)

Dear Sir,

In studying Interference of Light Waves we come across the example where two rays or more of light produce darkness but have not the apparatus to show this. If, however, the bifocal lens of the variety made by fusing two grades of glass together be held in the path of light the dark band will be seen on a piece of paper held as a screen.

This can easily be shown and explained taking into consideration a ray on each side of the transparent "joint." By allowing for their refraction according to the two refractive indices, they can be shown to come together from the same impinging wave front, and interfering produce darkness.

I am,
Yours, etc.,
R. SAXON, B.Sc., F.C.S.
Forster School,
Bradford.
July 2, 1927.

CHEMICAL SOCIETY OF JAPAN.

Papers communicated to the Society:—

"Studies on the Resistance Furnace for Higb and Low Tension." By Yohei Yamaguchi.

"Spectrochemical Studies on the Alkaloids of Isoquinoline Group." By Zenjiro Kitasato.

"On the Chemical Constituents of Vola Laqueata Sowb. (Pectinacea: Mollusca)." By Kiyohisa Yoshimura and Tetsuo Murota.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

15,954.—Bohme Akt.-Ges., H. T. — Method of renderong alcohols soluble. June 15th.

15,865.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of compounds from indene and phenols. June 14th.

16,245. Higgins, E. B.—Processes for carrying out chemical reactions at high temperature. June 18th.

19,092.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of naphthalene derivatives. June 16th.

15,758.—Sacchi, M. Casale.—Production of hydrogen. June 13th.

Specifications Published.

272,321.—British Dyestuffs Corporation, Ltd., Rodd, E. H., and Linch, F. W.—Process for preparing triarylmethane dyes.

Abstracts Published.

269,908.—Phosphoric acid.—Urbain Corporation, 292, Madison Aevnue, New York, U.S.A.

Phosphorus and hydrogen compounds of phosphorus are treated to obtain a concentrated solution of phosphoric acid. The materials are burnt in a chamber with air admitted through regulated openings. The products of combustion are passed up a Gaillard tower down which phosphoric acid flows. The gases which enter the tower at a temperature of about 900-1,100° C., and escape at about 200-280° C., are passed through an immersed nest of tubes in which they are cooled to 100-120° C. to avoid the condensation of steam, and into chambers filled with coke in which combination of phosphoric pentoxide and water takes place. Water may be sprayed into the con-

tainers. A solution of phosphoric acid is obtained and is passed by a pipe around the nest of tubes where it undergoes a preliminary concentration and thence by a pump down the tower where it undergoes a final concentration.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

PLESTRIN.

480,607.—All goods in Class 3 which includes chemical substances prepared for use in medicine and pharmacy.—Endocrines, Limited, 72, Wigmore Street, London, W.1. June 22nd.

MESODINE.

480,716.—Chemical substances prepared for use in medicine and pharmacy.—Bayer Products, Limited, 31 to 34, Basinghall Street, London, E.C.2. June 22nd.

WELLGROVE.

474,476.—Chemical substances prepared for use in medicine and pharmacy.—James Wellwood, 209, York Street, Belfast. June 22nd.

477,677.—A seal bearing a Fir Cone and Leaves, and the words FIR CONE, for chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—The White Sea & Baltic Company, P. and I. Danischewsky, Limited, White Sea House, 28, Great Tower Street, London, E.C.3. June 22nd.

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WANTED, a Second-hand Fortin's Barometer, cm. and inch scales; also Chemical Balances. — Write, "D," c/o *Chemical News* Offices.

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COUPLE DEPOSITION OF METALS.

By ROBERT SAXON, B.Sc., F.C.S.
Mem.Amer.Chem.Soc.

Electrodes of Meldrum's Acid Resisting Metal, hereafter called Marm, is used with the ordinary lamp current.

1. A helix is put in series with the anode and cathode alternately, between the electrodes in a solution of copper sulphate with crystals to saturate. The electrodes are in pyramid posture that is close at top and wide apart at bottom of liquid. In each case the deposit of copper is rapid. That at the base of the cathode is extremely tenacious, or we may say " well hammered." Behind the anode there is also a well hammered deposit pear-shaped broad end down. This hammered deposit is light deposit, is light coloured, and not easily eroded by acids.

2. These experiments are repeated without the helix and the deposit is not at all well hammered.

3. A helix fixed to the cathode but not touching the anode, being very near the latter at its free end, gives at the free end the pale blue hydroxide referred to in a former number of the *Chemical News*, in colloid form. The next coils have green hydroxide, and towards the middle red copper, getting lighter in colour as we approach the cathode, at the base of which we have again the well hammered variety. The helix of course forms a tunnel between the electrodes, and at its centre at the cathode end we have the most copper deposited.

4. A *helix is connected up in parallel* between the electrodes and in the liquid. The greater the resistance of the helix the more hammered is the deposit.

COUPLES.

1. An iron carbon couple standing vertically in copper sulphate and connnected outside the liquid, gives rich deposit of copper on the iron, and a finer one on the carbon. The solution remains clear eventually becoming ferrous sulphate, with small percentages of the -ous hydroxide. The action is at first displacement of copper by iron no hydrogen appearing. After that the copper carbon couple begins to work, and the resultant three couples at least, *viz.*, Fe Cu, Cu C, H C or H Cu effect the deposition of the negative metal.

2. Copper chloride gives a much more abundant deposit, and a clear solution of ferrous chloride, with little hydroxide.

3. Copper nitrate gives the ferrous hydroxide mixed with copper probably hydroxide in abundance in colloid form, with clots of brown hydroxide, along with the nitrate. This action is very slow.

4. With Marm similar results are obtained, but the action is a trifle quicker, and the liquid is freer from the hydroxides of iron.

These experiments serve to show that the harnessing of a displacing metal to a more electro-negative element greatly assists the depositing of the displaced metal, and this fact must be reckoned with in electrolysis with a supplied current. The attached helix displays a number of reactions taking place along its coils, but these are not completely understood at present.

AN ATOMIC MODEL FOR THE CHEMIST.—V.

By Florence Langworthy.

Sir Joseph Thomson tells us (Positive Rays, p. 92), that when lithium chloride is bombarded by cathode rays it shines with a blue phosphorescence and the spectrum is a continuous one; when it is bombarded by positive rays the phosphorescenee is red and the spectrum shows the lithium lines.

What, therefore, apparently happens is that negative arouses negative, and positive arouses positive, and not as we might well think would happen that negative would arouse positive, and positive, negative. The cathode rays, it would seem, rouse the electrons in the lithium chloride—in both atoms—and so we can understand a continuous spectrum being yielded. But when the positive rays are used only the lithium is roused. The negative chlorine is unaffected.

Many years ago Sir Joseph Thomson also drew attention to the fact that Hydrogen α is bright but Hydrogen β invisible near the positive electrode. Putting two and two together one is driven to the conclusion that Hydiogen β is the negative hydrogen atom with two electrons. And as Hydrogen β yields a green light and Hydrogen γ a blue light one is also led to believe that in Hydrogen γ we have the hydrogen atom with three electrons (H_3) for if to an atom of $H\beta$ reflecting green rays an outer electron were added that reflected the short violet rays, then we should get the mixture of green and violet rays that make blue.

In the previous articles the atomic planets have been shown departing as K X-rays, or as the longer L X-rays and becoming atoms of hydrogen on passing out of the ray stage. In both kind of rays the nuclei are circled by electrons having an impressed frequency, which is high or comparatively low according to whether the planet-ray has escaped from a heavy atom or a light atom. Since this frequency has been impressed upon the electrons while they were in the atom from which they escaped, it is easy to see that it will not last very long when they are free. For the electrons within the nuclei will soon be able to repel these circling electrons out to a distance more compatible with their common repulsion. Let us picture one of the short K X-rays as having its two circling electrons at first very near to the nucleus. Soon, however, the negative particle in the nucleus is able to force them out to a wider

now rapidly passing out of the ray state, is occluded by the sun-atom in a potassium atom—since it has two electron-planets attached to it. As the sun-atom is unable to repair its electron-planets with it the ray escapes. Its electrons will have been but a very short time in the corona—will have hardly been repelled thither before they fly away—the orbit of the electrons will soon expand. Such a ray, then, may well be an ultra-violet ray and the former K X-rays go to the making of the Lyman ultra-violet series of hydrogen lines. But when we come to the L X-rays we have rays of a much longer wave-length. Another positive is in the nucleus and there are three electrons circling about that nucleus instead of two. Let us picture an L X-ray that has just escaped from the atom, its three outer electrons retain their impressed frequency for only a very short time since they are repelled outwards by the inner electrons.

We will picture it as losing the outermost of its three electrons and so from being an atom of $H\gamma$ (H_3) it becomes an ordinary hydrogen atom with two electrons ($H\beta$). Then it loses another electron and becomes the still more ordinary hydrogen atom with one distant electron ($H\alpha$). In this way we can account for the Balmer series of hydrogen lines that are yielded when the atoms are excited. The degree of expansion of the orbit will necessarily depend upon the initial frequency. When the indium planet, for instance, flies off as L X-ray the impressed frequency of its outer electrons will be so high that they will not be repelled easily outwards by the inner electrons, whereas when the lithium planet flies off as an L X-ray the frequency will be so low, comparatively, that the inner electrons will have no difficulty in repelling the outer electrons. This they can do, it would seem, to such a distance that two of the outer electrons are lost almost immediately while the remaining one is afar off the nucleus.

Thus the ray will be speedily transformed into an atom that will appear when excited as $H\alpha$. Owing to this distance of the electron from the nucleus the red rays of light reflected by this positive nucleus will reach the eye unaffected by the electron. When, however, we have an L X-ray from a heavier atom, its electrons, although they will be repelled outwards will not be repelled so far as in the above-mentioned case. They will be nearer to the nucleus and thus will affect the reflected rays. So we can picture $H\beta$ with two electrons circling about it and reflecting only the green rays. With

nearer the nucleus and so the third electron *has been able to hold* on. The violet rays reflected by the third electron—for thanks to the nucleus about which it revolves it has an enhanced size—will thus be included *with the green rays reflected* by this negative nucleus and so the colour will deepen from green to blue. Still nearer to the nucleus will be the outermost electron in H· and more violet rays will be reflected, deepening the blue to indigo. Thus the atom will become smaller and smaller as we pass from the violet to the ultra-violet—until it becomes too small to reflect any visible rays.

It is therefore exceedingly doubtful whether an electron, by itself, could reflect a ray of visible light. If, however, a ray of light comes upon an electron, head-on, as the saying is, and that electron is revolving about a nucleus and so has an enhanced size, then a small ray of light, such as a violet ray, may well be reflected.

We are told that hydrogen's ordinary radiations are its X-rays and nothing more. Our atomic model apparently shows us why this is. Atoms that are heavier than hydrogen atoms—omitting helium atoms—contain an atomic sun and its system and so have planets to lose. Hydrogen atoms have neither sun nor planets. They represent the lost planets of heavier atoms.

We have seen that $H\gamma$ with three electrons becomes apparently—on the loss of an electron—$H\beta$ with two electrons. On earth it is a very easy matter to lose an electron *since there are so many positives to attract* the same to themselves. But should the atoms of $H\gamma$ (H_3) be so placed that they are not ravished of their third electron, almost *as soon as they are born, then these atoms* would have an opportunity of expanding—like the other atoms described—and so becoming slightly diferent from what they were. On earth they do not get this chance, but in the nebulæ they seemingly do, becoming nebulium.

The very high frequency radiation discovered recently by Professor Millikan and others as coming from the remote Andromeda and Hercules nebulæ and bombarding the earth, indicates that there are elements of higher atomic weight than uranium in the universe since the frequency is higher than that of the Gamma rays (X-rays) from uranium. And therefore it follows that there will be hydrogen atoms in the universe that are higher up in the ultra-violet than any upon earth. The discovery of this radiation also apparently solves the mystery of radio-activity. As we have seen it is necessary to bombard an element with X-rays or cathode particles of a higher frequency than those it emits itself if we want its own characteristic rays. The element, uranium, therefore, would be safe on this earth—since there is no element here of higher atomic weight—if it were not bombarded from outside. We find it disintegrating, spontaneously as it were, although we ourselves, seemingly, cannot affect it. As uranium, thorium and radium, are twin-elements their X-ray (Gamma ray) activity is somewhat masked by their Alpha ray activity, the outer twins departing thus. This high frequency radiation from Andromeda and Hercules helps us to understand how a nebula may originate. For let us suppose that our solar system were within close range of these two nebulæ so that a good deal more of their radiation reached us and let us also suppose that this radiation were of all frequencies, we should then—sooner or later—be reduced to a nebula ourselves. It is easy to see that if our solar system were thus treated it would take on the appearance of a spiral nebula—in the early stages particularly when the innermost parts of the planets had still escaped being riddled by the bombardment so that the planets appeared as blobs of light in the midst of the nebular haze.

In the " Novæ " we apparently see suns and their systems thus coming within dangerous range of such a bombardment. If we picture a sun on its journey through space as entering a region where a vast amount of this highly-penetrating radiation is being thrown off by another sun or by a nebula, then, this sun and its system may well blaze up into a temporary star or Nova. Its ordinary light may have been too insufficient to enable us to see it as a star, but now that so many of its atoms are disintegrating and thereby becoming ionised, *its light will be greatly increased. I quote* the following description of Nova Aurigae from Miss Agnes Clerke's *Problems in Astrophysics* (p. 208):— " Nova Aurigae *sprang into conspicuousness with the* stealthy speed of Jack's Beanstalk. On December 8, 1891, Dr. Max Wolf took, at Heidelberg, a photograph of the sky round *Aurigae, showing stars to the ninth magnitude.* The Nova was not among them; the spot destined for its occupation was vacant. Forty-eight hours later, as a Harvard negative attested, a fifth magnitude star filled the blank. . . . The spectrum was at once seen to blaze with bright lines, many of them greatly widened; and nearly all came out photographically as attended by

strong companions on their more refrangible sides. The entire hydrogen series, from crimson *C to the last of its ultra-violet* associates, was thus doubled, no less than the pre-eminent calcium pair, the sodium D, and a considerable number of lines since identified as originating from helium. An exceptional feature was the predominance of " green " helium; D_3 and the rest of the lines belonging to the " yellow " set were comparatively faint."

With our atomic model we shall expect to find *green* helium to the *front* in the case of dangerously high radiation penetrating matter contained by any solar system like our own. For as we have seen that the breaking down of the twin-planets, uranium, thorium, radium, will yield three atoms of green planetary helium to the one atom of yellow helium yielded by the sun-atom *when niton breaks up. In the next* series we shall have the same kind of thing. Polonium, lead and mercury, will give us three atoms of green planetary helium to the one atom of yellow helium *from the sun-atom* of that series. But when we come to a nebula we find—as we should expect—that yellow helium is seen and hardly any green. For in a nebula most of the heavier atoms have been broken up and so there is no planetary helium. The light atoms remaining can only show yellow sun-atom) helium when neon or argon disintegrates.

" During three months the Nova retained most of its brightness, despite wide fluctuations; then on March 6 a precipitate decline set in, bringing the object on April 26 to the limit of visibility with the great Lick reflector. . . . Observations resumed on August 17 ,1892, after its conjunction with the sun, showed, in the place of the vanished star, a stellar nebula of the tenth magnitude. . . As a star Nova *Aurigae* had been decidedly yellow; in its nebula stage it assumed a greenish tint."

The fact that Nova Aurigae turned to a stellar nebula undoubtedly indicates that it was not entirely disintegrated by the bombardment it received. The sun and its system—though drowned as it were in a sea of nebulium, were still there. That is should have been yellow as a star is not surprising from our point of view since the dangerous radiation would have been turning its atoms into double-positives as it broke them down. But when once the sun *has left* the danger-zone then the double-positives that have not escaped will pass out of their ionised state and what will be most in evidence will be the sea of nebulium. This, we have seen, is apparently composed of atoms that were first thrown off as L X-rays, the which, on *expansion, became* $H\gamma$ *atoms and finally*—since they can in a nebula keep a hold on their third electron — settle down into becoming atoms of nebulium. For in a nebula there is no positive matter worth mentioning to rob these atoms of their electrons as they are robbed on earth. But by degrees electrons are seemingly lost and these atoms that thus lose their outermost electrons and so become $H\beta$ atoms are left to form the fringe of the nebula,—possibly by force of gravitation on the heavier nebulium atoms. The colour therefore may *well be green.*

Miss Clerke writes : " As a rule the hydrogen spectrum in planetaries begins with the green line. The red line has been distinguished in only a few specimens, which *appear more condensed than the rest.*" We shall expect to find that only those parts of the erstwhile sun and its system that have not been disintegrated will be reflecting or throwing out red rays." Also, " The third hydrogen line, $H\gamma$, always shines unfailingly in nebulæ." This, too, we shall expect to find since it will be the transition stage between the L X-ray and nebulium atom. We shall only add to our difficulty in detecting nebulium on earth if we think of it as an element like oxygen or nitrogen that has a comparatively few spectral lines forming *a small group. Nebulium instead of* being an element is, in a sense, every element. Its spectrum will be different for each element that yields it up. We have, in all probability, come across it many times on earth but not recognised it.

That X-rays—which are practically weightless—should thus turn into hydrogen atoms with weight is not so strange as it may seem, for while the planet is an X-ray it is being violently repelled away *from* the atomic system and has not yet settled down to ours. When the planet was in the atomic system its positives were pulling upon the electrons from which they were separated and so originating weight. When the planet is being shot out of the system this sort of pull is likely to be in abeyance for a while. But when the planet is well away from its parent atom and has become an atom on its own account the " pull " is re-established. Even we ourselves if we were shot into the air by an explosion *would be to all intents and purposes* without weight during our ascent.

" Bourget, Fabry and Buisson have concluded that there exists in the nebulæ an element of the atomic weight about three,

basing their estimate on the broadening, by Doppler effect, of the lines of unknown origin in the spectra of the nebulæ, to account for which gas, nebulium, has been postulated. Rydberg, too, decided some years ago, on spectroscopic grounds, to create two new elements between hydrogen and helium."*

It is thought by many that nebulæ are solar systems—and even in some cases, universes—in the process of formation. I thought so once myself, but now I see that though a universe or a solar system in course of construction might bear a striking resemblance to one in course of destruction, yet there is one thing that would be absent from the former process and that is nebulium. Our atom shows us that it is the product of decay. Regarding nebulium thus and bearing in mind the discovery of dangerous radiation, we have our eyes opened in a surprising way. Since the Pleiades, for instance, are a cluster of nebulous stars travelling together, we can understand how it is that they are linked together in their nebulous haze by nebulous streamers, for if one of them is giving out the dangerous radiation then the others may well be compelled to follow suit with the result that they are all "tangled in a silver braid." We can also understand why one of the Pleiades has disappeared within the memory of man, without having to ascribe it—as did the Greeks—to the grief that she felt at the destruction of the House of Dardanus.

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* E. N. da C. Andrade, D.Sc., Ph.D.: *The Structure of the Atom*, p. 90.

GAS JOURNAL.

The Institution number was issued on June 22, and comprised no fewer than 254 pages. While advertisements loomed large, reports, articles and illustrations made a fine display. Special attention and considerable space is given to the report of the Annual Meeting of the Institution of Gas Engineers, the photographs being numerous and included a page group of the guests of the President and his wife at the reception. The number is a very creditable production. Among the scientific matter was an interesting paper by Hamilton Davies, B.Sc., and Harold Hartley, D.Sc., on "Further Investigation of Iodine Pentoxide Method for Determination of CO."

REPORT OF H.M. INSPECTORS ON THE PROVISION OF INSTRUCTION IN PURE CHEMISTRY IN TECHNICAL COLLEGES AND SCHOOLS IN ENGLAND.

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(*Continued from Page 22.*)

Occupations of Students in Part-time Courses.

The title of a course, except in courses (*e*) and (*f*) in the table (this vol., p. 21,) is no indication of the occupations of the students. In classes in Chemistry these are very varied, and there are relatively few cases in which a separate course for students of special needs is arranged. Particular requirements are met by classes in Applied Chemistry or the Technology of occupations or industries. A broad classification of the occupations of 10,379 students is given in the following table :—

Number of Students engaged in :—

Chemical Industry	
(a) In laboratory work	2,450
(b) In the factory	1,309
(c) In clerical and commercial work	651
Retail Pharmacy & Dispensing	2,324
Other occupations	3,645

It is highly probable that on a more detailed analysis many of those classified under "other occupations" would be found to be engaged in occupations which are primarily chemical in character.

Qualification of the Teachers.

While the full-time and part-time day courses are taught by permanent teachers of the Technical School, these are assisted in the relatively large volume of evening work by teachers who are otherwise engaged in the daytime. Many of these are employed in Secondary Schools, Junior Technical Schools, or Central Schools, and others are engaged in industry. A very large proportion of both groups are University graduates. Thus in one area there are 57 teachers engaged in full-time courses, and 53 of them are graduates. Of the 80 teachers engaged in part-time courses, 44 are graduates, three are Fellows and three are Associates of the Institute of Chemistry. In another area 34 out of 38 teachers engaged in the instruction of full-time and part-time day students, are graduates; of these 12 are also Fellows and 13 are Associates of the Institute of Chemistry, and of the other 4 one is a Fellow and two are Associates of the Institute of Chemistry. In the evening classes there are in addition 12 graduates of whom 2 are Associates of the Institute of Chemistry, while of the 50 teachers employed in the area the only one

who has no academic qualification is an exceedingly capable laboratory instructor of very long experience. The general standard is therefore high, and is almost in itself a guarantee of the fullness and accuracy of the instruction.

ACCOMMODATION AND EQUIPMENT.

In all centres where full-time work is undertaken, and in most of the part-time centres, the instruction is given in a Technical School, though in some cases a Secondary or Junior Technical School is held in the same premises. In some of the smaller towns where there is no Technical School, the Secondary School or more rarely a Central School, or some other building, is used. Except in a few centres, the accommodation is satisfactory. Most of the schools have separate lecture-rooms, and there are few cases in which theoretical instruction has to be given in a laboratory. Most of the schools have separate laboratories for physics. The larger institutions have usually two or more laboratories for chemistry with adequate accommodation for storage and preparation. But in many of the smaller schools provision for storage and preparation is less adequate. Where the laboratory is used jointly by a Technical School and a Secondary School, the arrangements made for the allocation of responsibility are generally satisfactory. In most schools a laboratory assistant is employed. In nearly all cases there are adequate stocks of apparatus and materials, and a stockbook is kept, and there are very few cases indeed in which the condition of the laboratory or apparatus is unsatisfactory. Only the larger schools have libraries, and there is perhaps more need for improvement in this than in most other respects.

It is obvious therefore that in general the accommodation and equipment are satisfactory. On the other hand there are a limited number of centres in which the laboratory accommodation is insufficient, there is too little space for storage and no room for preparation of apparatus and material, difficulties arise by joint use of the laboratories, and perhaps a large number of centres in which books of reference are not provided.

CONSTITUTION AND DURATION OF COURSES.

Full-time courses usually cover 25 to 30 hours a week for one, two, three or four years. In London and the south they are based mainly on the requirements of London University, and the time devoted to Chemistry varies from 8 to 21 hours per week. In the midlands, in cases where the distribution of time is not determined by the requirements of University Examinations, it is usual to allocate 9 hours for Chemistry, 8 hours for Physics, and 6 hours for Mathematics, the remainder of the time being devoted to Machine Drawing of a Modern Language. In the north the courses include some Applied Chemistry, and one or more Engineering Subjects. All courses include adequate laboratory instruction.

Part-time courses in the midlands and north consist usually of Mathematics, Physics, and Chemistry in the first year; Physics or Physical Chemistry, Inorganic Chemistry, and Organic Chemistry in the second year; and Inorganic, Organic and Physical Chemistry in the third year. A few schools provide Mathematics in the second year and include the elements of Physical Chemistry in the Inorganic Chemistry. Further, in the north a good many schools take a branch of Applied Chemistry in place of Physical Chemistry in the third year. Where Metallurgy is a subject of the third year, it usually replaces Organic Chemistry. A few schools introduce a branch of Applied Chemistry in the second year. As the classes meet for only three nights a week this plan reduces the time available for laying a sound scientific foundation, it results in the study of technical preblems either in an empirical way, or in the study of processes which the student has not sufficient chemical knowledge to understand, and it is not to be commended. On the other hand, the introduction of a suitable branch of Applied Chemistry into the third year is less objectionable. It may not be an ideal plan, but, if the syllabus does not involve more chemical knowledge than the student has acquired, its direct bearing upon his occupation is decidedly stimulating. And it is only schools attended mainly by students who are engaged in work which is on the scientific rather than the practical side of industry which have been able to withstand the demand for specialised instruction in the third year of the course.

In many schools the courses cover five years, and in a few, six years. The first three years are known as a Senior Course, and the next two or three constitute an Advanced Course. There are three centres where the Senior Course is spread over four years. In the North the Advanced Courses consist either of a further study of Chemistry and Physics, or of Applied Chemistry, with Inorganic or Organic Chemistry, or both.

Courses in the south do not differ greatly from those in the rest of the country, but as a rule they are based more definitely upon

the requirements of University examinations. It has already been remarked that many evening students of Pharmacy attend the classes in Chemistry in National Certificate or similar courses, or in University courses. There is a growing tendency for students to prepare for the Associateship of the Institute of Chemitry in both full-time and part-time courses.

Nearly 80 per cent. of the part-time students referred to in the table on page 3 are enrolled in courses of instruction involving attendance on three evenings a week, and including instruction in the subsidiary subjects of Mathematics and Physics. Further, students of Applied Chemistry are receiving instruction in Mathematics, Physics, and Pure Chemistry.

(To be continued.)

INSULIN AND ITS MANUFACTURE.

By F. H. Carr, F.I.C.

(President of the Society of Chemical Industry.)

(Before the Royal Society of Arts, February 23, 1927.)

(Continued from Page 25.)

The main part played by insulin both in the healthy and diabetic man or animal is therefore to promote the storage of sugar in the form of glycogen and also, to some extent ,its oxidation of sugar. In normal metabolism some sugar is formed in the liver, from protein and possibly from fat. Dale and his colleagues have shown that insulin depresses this formation in the liver of glucose from protein and fat. In the diabetic and probably also in the normal individual sugar is produced from fat, but in the diabetic certain abnormal products of fat metabolism are formed, namely aceto-acetic acid CH_3COCH_2COOH and $CH_3—CO\ CH_3$, and these are excreted in the urine. There is frequently also present what is obviously the parent substance of these two compounds, namely, hydroxybutyric acid $CH_3.CH(OH).CH_2.COOH$. These substances result from the imperfect oxidation of fats. Not only, therefore, is a diabetic unable properly to dispose of carbohydrates, but the fat is not oxidised to the normal end-products CO_2 and H_2O. Insulin treatment causes the rapid disappearance of aceti-acetic acid as well as sugar from the urine. It seems likely that insulin acts primarily upon the sugar metabolism, and that fat metabolism cannot proceed normally without simultaneous occurrence of the former process, but we have to await the final elucidation of this and a host of other problems of a similar nature. The discovery of insulin has given a new and very valuable method of investigating body metabolism, opening out a vast field for research.

While insulin is necessary to prevent the accumulation of sugar in the blood beyond the point at which the sugar, so to speak, becomes harmful to the body and interferes with the cell processes, on the other hand, too much insulin reduces the sugar to a minimum figure and acts as a poison, causing severe symptoms and ultimate death.

There is, moreover, stored in the pancreas of a normal person insulin much more than sufficient to cause death were it all released from the cells in which it is stored and allowed to enter the blood stream at the same moment.

This release of insulin by glucose is well shown in some experiments of Burn and Marks. Rabbits given doses of thyroid daily finally lose all the glycogen in their liver : an intravenous injection of a small amount of glucose now produces death from hypoglycaemia, by the stimulation of insulin secretion from the pancreas, and no recovery can occur as there is no store of glycogen in the liver to replenish the sugar of the blood !

If the mechanism of this release of insulin failed to act, diabetes would result through there being a deficiency of it in the rest of the body, but it is more commonly supposed that diabetes is caused by the failure of the pancreas to form insulin. The question which of these is the real cause still awaits experimental solution.

The fact that insulin is very sparingly soluble in water at its iso-electric point, namely $pH5$, and that a small adjustment of the hydrogen-ion concentration either to the acid or the alkaline side of this iso-electric point renders it readily soluble, may conceivably explain the release of insulin from the cell tissues to the blood as being caused by minute variations of the hydrogen-ion concentration of the body fluid at that point.

The Manufacture of Insulin.

For the purpose of manufacture there is used ox, pig or sheep pancreas available from abattoirs.

Almost immediately after the death of the animal a loss of insulin through proteolytic action begins, for although during life the insulin remains in the tissues apparently unaffected by the trypsinogen, soon

after death the latter becomes activated and the islet tissue becomes transfused by dissolved enzymes. Their action may, however, be arrested : (1) by the addition of alcohol of such a strength that the enzyme is precipitated; (2) by bringing the temperature below zero; (3) by rendering the fluid more acid than pH 3.5 by the addition of sulphuric or hydrochloric acid.

The preparation of insulin comprises extraction and subsequent purification. During the extraction an dearly stages of purification every advantage must be taken of these methods of delaying the rate at which its natural destruction proceeds. Once the destroying enzymes have been removed, the substance is stable if kept sterile. In outline the method of preparation consists of :—

(1) Procuring, dissecting and cooling the pancreas glands as rapidly as possible after the death of the animal.

(2) Grinding or mincing at a low temperature to break up the cells very thoroughly.

(3) Rendering the material acid to pH 2.5 or alkaline to pH 7.0, in order to set free the insulin from the tissue on which it is adsorbed.

(4) Extracting it with alcohol of such a strength that but little of the enzyme is dissolved, and as much as possible of the insulin. For this purpose alcohol of 65-70 per cent. has so far proved the best solvent.

(5) Clarifying this extract by cooling it to -5° and filtering or centrifuging it.

(6) Concentrating at a low temperature to 1-10th of its volume, extracting the fat and filtering.

(7) Precipitating the proteins with ammonium sulphate or with absolute alcohol at pH 5.

(8) Precipitating the protein mixture by adjusting the aqueous solution to pH 5.2. Proteins which are precipitated above and below pH 5.2 do not merely dilute insulin but are antagonistic to its action. This purification is consequently of great importance.

(9) Finally, formation of the picrate and regeneration as a hydrochloride by Dudley's method. By this means alone 90 per cent. of the inactive protein may be removed from some samples of crude insulin, since, although insulin when pure may be almost completely precipitated at its iso-electric point, the presence of accompanying proteins tends to keep it in solution, even at this point.

Purification is thus effected by combining the use of precipitants such as picric acid and ammonium sulphate with iso-electric point precipitation.

The laboratory method of preparing insulin has been published in detail by many workers. Particular attention may be drawn to the work of Banting, Best, Collip and Macleod, Dudley, Dudley and Starling, Doisy, Somogyi and Shaffer.

The principles of the method having been described, it will be best to deal at once with the process as interpreted on the large scale.

The large-scale manufacture has been installed as a continuous process. The plant has been so arranged as to ensure rapid handling, continuous recovery and strengthening of alcohol, automatic control of temperature and so forth. Its chief interest lies in its arrangement, which cannot readily be described but may be better understood with the aid of lantern slides.

When first this manufacture was commenced the yields obtained were very low, though quite as high as those obtained in other laboratories, being but 50 units per kg. of pancreas. There was also at first a great loss of alcohol. As our knowledge has extended and the plant has been perfected, it has been possible to increase the yield twenty-fold and to reduce the loss of alcohol to a very low figure. So great progress could not have been made without the assistance given by communications from many workers in the field, both in this country and in America and Denmark. In particular, mention must be made of the invaluable help given by the National Institute for Medical Research. As the result, the selling price of insulin was reduced by successive stages from 25s. to 2s. 8d., per bottle of ten doses within the first year of its manufacture, thus bringing the cost of treatment, at first prohibive to many, within the reach of all. At the same time we have been able greatly to improve the purity of the insulin as it is issued for use.

(To be Continued.)

Studies in the Growth of Grapes. By R. Copeman, B.A., B.Sc., Div. of Chemistry, Cape Town.

This is a 294 pp. report from the Transactions of the Royal Society of South Africa. The main subjects dealt with are

(a) Acidity of the Juice;

(b) Sugar Content of the Juice;

(c) Soluble Solids in the Juice;

(d) Total Solids in the Berry.

PHARMACEUTICAL SOCIETY OF GREAT BRITAIN.

Pharmacological Laboratories. First Annual Report, 1926.

The organisation of the pharmacological laboratories began in January last; since then the work done has consisted, on the one hand, of the testing of various therapeutic substances sent by manufacturing firms, and, on the other, of research work which in the main has been directed to the establishment of more accurate conditions for carrying out such testing.

In March last the number of substances which the laboratories were prepared to test was limited to preparations of digitalis, strophanthus, and squill, ergot, and pituitary extract. Since then the list has grown. Samples of adrenaline, ovarian extract, and parathyroid extract have been tested, and determinations of the toxicity of sodium tetraiodophenolphthalein have been made. During the summer the Council decided to establish a vitamin-testing department, and this, under the direction of Dr. Katharine Coward, will shortly be ready to receive samples.

Digitalis.

Seventeen samples of digitalis have been received. Of these, three were samples of leaf and fourteen of tincture. In all, three were rejected—one because it was too weak, two because they were too strong; the remaining fourteen conformed to the requirements of the League of Nations Conference, September, 1925.

The majority of these samples were tested by the cat method in comparison with the international standard for digitalis. This method has been found satisfactory, but investigation of other methods is proceeding.

Strophanthus.

While the League of Nations Conference had recommended the use of ouabain as a standard for strophanthus, the only information available respecting the strength of a good tincture of strophanthus in terms of ouabain was that appearing in the United States Pharmacopœia. As a result of work carried out in the laboratories, it has been found that this information is inapplicable to tinctures obtainable in Great Britain, and a suitable standard has been determined. This may be expressed by saying that an average tincture of strophanthus should be equivalent to a solution containing 0.85 per cent. ouabain. Observations made in conjunction with Dr. J. W. Trevan have established that the assay of strophanthus in terms of ouabain is the same whether carried out by the cat method or the frog method.

During the year two samples of tincture of strophanthus have been examined on behalf of manufacturing firms.

Squill.

No standard for squill has yet been suggested by the League of Nations Conference, though in the United States Pharmacopœia the use of ouabain is demanded. Work carried out in the laboratories, again in conjunction with Dr. J. W. Trevan, has shown that ouabain cannot be used as a standard, inasmuch as the assay in terms of ouabain by the cat method gives a different result from the assay by the frog method. An investigation of scillaren, the crystalline glucoside obtained from squill by Stoll, as a standard for squill is proceeding at present, and it is hoped to publish the results shortly.

Ten samples of tincture of squill have been examined during the year.

Ergot.

At the opening of the laboratories it was decided not to accept the liquid extract of ergot in the British Pharmacopœia for assay, because this does not contain the specific alkaloid of ergot. This decision carried with it the obligation to take steps to determine the actual therapeutic value of the different physiologically active substances present in ergot. This work, carried out at Queen Charlotte's Hospital together with Mr. A. W. Bourne, F.R.C.S., is approaching a successful conclusion; it may be said that the results completely vindicated the policy adopted by the laboratories.

Clark's method of assaying ergot has provided for the first time a means of determining the percentage of specific alkaloid in the crude drug with reasonable accuracy. Miss J. M. Ellis, Ph.C., lately elected Redwood Scholar, has investigated the accuracy of the method, and has assayed nine samples of crude ergot obtained from different sources. The results show the importance of such an assay, as there are much wider variations in the content of specific alkaloid than occur in other drugs such as digitalis, strophanthus or squill. It is clear that so soon as the Pharmacopœial preparations are altered so that they contain the specific alkaloid, it will be essential for manufacturers to arrange for the crude drug to be assayed before they buy it. The results of this investigation will be published shortly.

During the year fifteen samples of extract of ergot have been tested for manufacturing houses. There were all prepared by the use of an acid alcoholic menstruum.

PITUITARY EXTRACT.

Fifteen samples of pituitary extract have been tested for manufacturing houses.

A clinical investigation, together with Mr. A. W. Bourne, F.R.C.S., at Queen Charlotte's Hospital, into the proper dosage of pituitary extract in labour is rapidly reaching a successful conclusion, and the results will shortly be published.

An investigation into the anti-diuretic effect of different samples of pituitary extract has been undertaken at the request of the League of Nations Health Committee, and it proceeding at present.

An investigation has been carried on of the effect of pituitary extract in certain metabolic conditions, but little progress has been made.

OVARIAN EXTRACT.

Three samples of ovarian extract have been tested during the year.

Dr. Katharine Coward, since taking up her appointment in October, has devoted a considerable portion of her time to a study of the variation in a large number of rats and mice in the response to given doses of the œstrous-producing hormone. Her work is still proceeding. As a result, it is hoped that it will be possible to define the conditions necessary to assay samples of ovarian hormone with a given degree of accuracy.

General Notes.

BOARD OF TRADE ANNOUNCEMENT.

MERCHANDISE MARKS ACT, 1926.

EXEMPTION OF UNCOMPOUNDED DRUGS.

The Board of Trade have exempted uncompounded drugs, from whatever source derived, which are sold for medicinal purposes, from the requirement that imported goods bearing a British name or trade mark must also bear an indication of origin. The exemption does not apply, however, if the drugs are sold or exposed for sale under a proprietary name.

Note.—The Board's direction appeared in full in the *Board of Trade Journal* of the 30th June and the London, Edinburgh and Belfast *Gazettes* of the 1st July.

TAXATION OF FOREIGN LIMITED COMPANIES IN ROUMANIA.

The Board of Trade have received a translation of a Circular Order issued by the Roumanian Ministry of Finance, which draws attention to the conditions which must be fulfilled when foreign limited companies establish branches or representative companies in Roumania.

They must, *inter alia*, declare the capital with which it is proposed to undertake operations, as this figure is required by the Roumanian Authorities for estimating the amount of the supplementary tax on branches of foreign limited companies with head offices outside Roumania, and in its absence the profits are assessed at the maximum figure of 500 per cent.

The text of the Circular can be consulted at, or obtained from, the Commercial Relations and Treaties Department, Board of Trade, Great George Street, London, S.W.1.

WORLD'S OLDEST REFRIGERATION SOCIETY.

In view of the important part that refrigeration is playing in the life of the nation to-day, it is interesting to hear that to this country belongs the distinction of having first established a national society of refrigerating interests, *viz.*, the British Cold Storage and Ice Association, which was founded in 1900. This instituion, after over a quarter of a century of existence, has at its annual meeting recently changed its name to "The British Association of Refrigeration," as its representation of the great industry of mechanical refrigeration and all its many applications has long extended beyond the cold stores and ice interests indicated in the old title. To the refrigerating industry of Great Britain belongs the great task of securing the fresh condition and the purity of a large proportion of the perishable food supplies of the nation which, before the institution of the amended Food Regulations, were often treated with chemical preservatives.

ELECTRO-CHEMICAL INDUSTRIES OF THE NIAGARA PENINSULA.

The principal electro-chemical industries established in the Niagara Peninsula are engaged in the production of artificial graphite, electrodes, calcium carbide, cyanamide, calcium-sodium cyanide, silicon carbide, and aluminous abrasives.

Artificial graphite is made by the Acheson Graphite Company in a plant near Niagara Falls, Ontario, from imported selected anthracite. High grade foundry coke or petroleum coke are also used.

Calcium carbide to be used for the production of acetylene gas is made in two plants from local limestones and imported coke.

Calcium cyanamide and calcium cyanide are made by the American Cyanamide Company in a large plant located at Niagara Falls. Local limestone is burned in a modern rotary kiln to lime; the lime in turn is fused with coke in hugh electric furnaces to make calcium carbide. In another unit pure nitrogen is prepared by compressing air to about 40 atmospheres under such conditions that liquid air is formed; nitrogen is distilled off at a temperature about 300 degrees Fahrenheit below zero. Crushed carbide is treated with pure nitrogen in special electrically heated ovents at a temperature of 2,000 degrees Fahrenheit, for the production of crude cyanimide. Crude cyanamide may be shipped as such to other plants for further treatment or for use in the production of fertiliser products sold as " soilime " or " ammo-phos " or for making certain chemicals (urea, ammonia products, nitric acid); selected lumps are used in case hardening; and some is hydrated and oiled for use in fertilisers. One of the most important products of this works from the metallurgist's point of view is a product sold as Aero brand cyanide. This contains calcium-sodium cyanides, the cyanide strength being equivalent to 49 or 50 per cent. sodium cyanide. It is made in special electric furnaces by fusing cyanamide with common salt. The product is sold in the form of greyish-black flakes of irregular area, about one-half a square inch more or less and about one sixteenth of an inch thick. It is used in Canada for cyaniding gold and silver ores; it is also suitable for use where cyanide fumigation is needed and in the production of the cyanogen compounds.

Artificial abrasives, made in several plants, are of two classes, silicon carbide an aluminium oxide. Silicon carbide in crystal form is made in special furnaces from coke, sand, and hardwood sawdust to which a little sodium chloride has been added. This product, sold under the trade name " carborundum," is made by the Canadian Carborundum Company, at Niagara Falls. Other firms making a similar product are the Norton Company, with a plant at Chippawa, near the Falls, and the Exolon Company, located at Thorold, on the Welland Canal. Carbide of silicon as an abrasive is marketed under several different trade names, such as carborundum, carbolon, carbosolite, crystolon, or electrolon.

The other important artificial abrasive produced in the district is artificial corundum, marketed under a variety of trade names, such as aloxite, alundum, coralox, borocarbone, exolon, natite, and artificial alumina.

Finished abrasive products, such as stones and wheels, are made by the Norton Company at Hamilton and the Brantford Grinding Wheel Company at Brantford. The first-named company operates gas-fired kilns for vitrified binders and two small electric furnaces for silicate and shellac binders. The second company operates gas-fired kilns and furnaces. The Dominion Abrasive Wheel Company, located at Mimico, near Toronto, operates gas-fired kilns and a coal-fired furnace.

AMERICAN INDUSTRIAL PROGRESS THROUGH SCIENTIFIC RESEARCH.

By EDWARD R. WEIDLEIN, Sc.D.

(President, American Institute of Chemical Engineers; Director, Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.)

Abridged.

Let us first turn our attention to an industry that was born and brought into commercial usefulness within the last twenty-five years. Dr. L. V. Redman, who has had an important part in the development of the phenol-resin industry, has supplied the following account of its growth through research.

Beginning with Dr. Baekeland's discovery of a proper method of controlling the production of phenol resins, their subsequent hardening under heat and pressure, and their increased strength when fillers are used, particularly fibrous fillers, these discoveries have made possible the application of phenol resins in technology in the widest and most varied manner. They have made possible the rapid and cheap production of distributor heads and rotors for automobile ignition. The accuracy of dimensions with which these phenol resins can be moulded and their permanence of shape under elevated temperatures, such as one gets under an automobile hood, has made their application very extensive in the automobile industry.

Another very prominent branch of manufacture is the rubber industry, which has been developed enormously in the last twenty-five years. In 1900 rubber products factories were few, and the chemist as a forward-working research man was rare in

the industry. Since then, however, factories and research laboratories have grown, until to-day rubber stands out as one of our most important industries. Dr. W. C. Geer has ably presented the development of this industry in an article printed elsewhere in this issue which covers both research and operating advances.

The American Telephone and Telegraph Company carries on its research and development work for the Bell system through the joint agency of two groups: one, the department of development and research of the American Telephone and Telegraph Company, and the other, the Bell Telephone Laboratories. The work of these two groups is closely correlated and is in effect a single operation under one executive. Dr. F. B. Jewett, who has played such an important part in the development and expansion of the research activities of this great corporation, has recounted some interesting information to strengthen our contention that research is of high value to the community.

The elaboration and development of the telephone systems of remote control by relays, switches, etc., have made commercially possible in large and small centres of population the use of mechanical automatic systems, involving machine switching central offices and private branch exchanges, dial telephones, and all their associated apparatus.

Carrier telephone systems have been perfected, using the principle of modulated high frequency currents in apparatus meeting the exacting requirements of telephone operation.

Radio apparatus and systems have been developed not only for broadcasting transmission, but more essentially for telephone communication; the result has recently appeared in the introduction of the trans-atlantic radio telephone link between the land systems of England and America.

The testimony of Dr. W. R. Whitney and Dr. L. S. Hawkins lends additional support to our contention that research is of inestimably high economic value. Their *résumé* of the work of the research laboratory of the General Electric Company is very concise but impressive in what it records. Drawn tungsten made the tungsten lamp robust and relatively inexpensive, and so made it capable of universal application. A portable X-ray outfit brought X-rays to the bedside of the patient. The oil-immersed dental outfit made radiography safe for dentist and patient. The latest developments of the laboratory are the high power cathode ray tube and the atomic hydrogen welding. We are all familar with the General Electric's advances in the fields of lighting, radio, X-rays, alloys, insulation, calorising, and rectification—progress that has been made possible by scientific research of the most painstaking and thorough type, conducted by scientists and engineers of high ability and actively supported by the executives of the company.

The research department of the Westinghouse Electric and Manufacturing Company is likewise covering a broad field of scientific investigation, as outlined by S. M. Kintner.

The work that has been done in the Westinghouse laboratories by Yensen, Brace and others on magnetic steels represents a prominent accomplishment and has tended to improve materially the practice of the steel companies from which the Westinghouse Company's requirements are purchased. These men have found what it is possible to expect from very high grade materials and have evaluated the influence of each of the several impurities generally occurring therein.

The bringing of aluminium into the ranks of the cheaper metals has been wonderful and chemistry has been the pathfinder. Dr. Francis C. Frary and Dr. Earl Blough state that one of the notable results of recent research is the Hoopes process of electrolytically refining aluminium. By this process the Aluminium Company of America has been able for the first time actually to carry out on a large scale the electrolytic refining of the molten metal in a molten bath, and can produce aluminium of purity as high as 99.97 per cent. The high resistance to corrosion shown by this high purity metal makes it seem probable that it will eventually find important industrial applications where a light-weight metal of such a type is needed.

The work of F. M. Becket and of other scientists and engineers of the Union Carbide and Carbon Corporation shows clearly the sympathetic attitude of our great corporations toward research.

This corporation's research is conducted at a central laboratory in Long Island City, and in other experimental laboratories under jurisdiction of the respective subsidiary companies at Buffalo, Cleveland, and Charleston, W. Va. A development laboratory operating on the scale of a small producing plant is also maintained at Niagara Falls. As a result of many years' work in these laboratories, the Corporation is firmly convinced of the value of co-ordinated research, on fundamental principles as well as on commercial problems, and hopes to expand this field of activity.

Mr. W. H. Bassett, of the American Brass ompany, points out still other research ccomplishments in the field of metallurgy.

The application of the metallurgical iicroscope to non-ferrous metals and alloys as begun just about twenty-five years ago, ad resulted in the understanding and conol of the hardening of copper and copper lloys by cold working. It also made possile the clear comprehension of grain growth ad its control, as well as the control of hysical properties by heat treatment.

Researches into season cracking revealed ie causes of the spontaneous cracking of rtain alloys and also methods for preven-on and control.

Researches into the effect of small nounts of impurities in metals and alloys ive resulted in the obtaining of metals in very high state of purity and marked imrovement in quality and usefulness. This ork has required research into methods of iemical analysis and of spectrographic ialysis.

Studies on the structure and corrosion of indenser tube alloys have greatly improved the quality and length of service to obtained from condenser tubes, for both arine and power-station service.

Dr. Paul D. Merica, who likewise has been progressive factor in the metallurgical eld, has related some of his activities in cent years with the International Nickel ompany.

During the past five or six years a great al of research and development work has en done concerning the effect of combinaons of nickel and chromium in cast iron id the industrial applications of such loyed iron products.

Another series of researches, carried out ostly by the International Nickel Comny, and which has been going on for veral years, is the study of the corrosionsistance of Monel metal and of nickel.

Among process researches may be menoned the study of the operation of depositg nickel electrolytically. By studying the ect of current density, temperature, drogen-ion concentration, as well as of rtain other variables, it has been possible improve the electrolytic deposition of ckel, particularly with respect to the irity of the resulting product. Electrolytic ckel now on the market contains approxiately 99.9 per cent. nickel (plus cobalt). is very free from copper, iron, carbon and lphur.

G. W. Thompson and Dr. R. L. Hallett ve given the following brief account of eir chief achievements :

During the past quarter century, progress has been made along many new lines and useful materials and processes have been discovered and developed which were not known at the beginning of the period. The research department of the National Lead Company has had an active part in some of these developments, among which are the use of titanium oxide in paint, the invention of Frary bearing metal, and the development of the Thompson-Harris process for the separation of the so-called " white metals."

The liquefaction of the so-called permanent gases as well as the fractionation of the liquefied gases were first developed industrially by the Linde Company approximately twenty-five years ago for the express purpose of producing oxygen from liquid air on a commercial basis. As might be expected, the results obtained during this development period lacked many of the refinements that are used in the art to-day and which have been worked out during the last decade as a result of a large amount of physico-chemical and chemical engineering research. This research has made possible the following advances in the art of rectification of liquefied gases : the reclamation of a larger amount of the oxygen content from the air than was previously possible; the production of nitrogen suitable for industrial purposes; the simultaneous production of pure oxygen and nitrogen; and the separation of argon, neon, and helium from air on a commercial basis.

The mass of valuable fundamental physical and chemical data developed in the course of research in perfecting these processes has found readp application in the extraction of helium, as well as other components, from natural gas. The technic eovlved has also provided the scientific basis on which the Linde air Products Company, during the World War, was able to build its successful helium production units at Fort Worth, Texas. Numerous refinements in the first helium plant have been accomplished by continued research; but the original engineering resigns, although distinctly noevl in type, were an actual commercial success, largely because the earlier research had dealt with fundamentals. This wartime achievement, the conversion of a chemical curiosity to a commercial balloon gas, is a striking example of the adaptability of well planned industrial and scientific investigation.

(To be Continued.)

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read at the meeting held on June 23 :—

On the Nature of Wireless Signal Variations.—I. By E. V. APPLETON, F.R.S., AND J. RATCLIFFE.

(1) Two methods of measuring the angle of incidence of downcoming wireless waves are described. The two methods have different ranges of applicability. Both involve photographic registration. The first method utilises the ordinary night-time signal variations and can be employed in connection with any steady transmitting station. It only yields useful results if the natural signal variations are small. The second method requires a controlled wave-length change at the transmitter, but may be used even when the natural signal variations are large.

(2) The mean values of the angle of incidence, as measured by these two methods, for the periods immediately following sunset and preceding sunrise, show a close agreement, and lead to an effective height of 90-100 kms. for the atmospheric deflecting layer.

(3) Observations of the angle of incidence, made by these methods, indicate a diurnal variation in the height of the ionised layer, which is found to be higher in the middle of the night than during the sunset and sunrise periods.

(4) Comparatively rapid fluctuations have been observed in the angle of incidence of downcoming waves. Such fluctuations are not considered as being due to variations in the height of the ionised layer, but are explained by supposing that "reflection" takes place at different points on a layer the mean height of which is sensibly constant. Such variations might be expected if the layer were not of sensibly uniform horizontal stratification.

On the Nature of Wireless Signal Variations.—II. By E. V. APPLETON, F.R.S., AND J. RATCLIFFE.

(1) An account is given of experiments on the nature of the variations of downcoming wireless waves responsible for nocturnal signal variations. By employing a receiving assembly which is a combination of a loop and vertical aerial, it has been possible to eliminate the effects of the ground waves at the receiving station, and to study the characteristics of the downcoming wave directly. Large variations in intensity of downcoming waves are found.

(2) It is pointed out that fading may be due to changes in any of the following variables which determine the nature of the downcoming waves :—(*a*) Angle of incidence, (*b*) intensity, (*c*) phase, (*d*) polarisation.

It is shown that for wave-lengths of about 400 ms. and distances of about 80 miles, fading is chiefly due to changes in the intensity of the downcoming waves. Variations in the phase relation between ground and sky waves are a secondary cause of fading. Changes in the angle of incidence or polarisation of the downcoming wave are not responsible in any very marked degree for signal variations.

(3) The downcoming ray has been shown to be of complex polarisation, having electric vectors both in, and at right angles to, the plane of propagation. Similar intensity variations are found in both these vectors.

(4) The use of a suppressed atmospheric ray system in reception for minimisation of fading and in transmission for preventing emission of upward rays is discussed. Such a system may be used to find the angle of incidence of downcoming rays in the absence of direct rays.

The Efficiency of K-Series Emission by K-Ionised Atoms. By L. H. MARTIN. Communicated by Sir Ernest Rutherford, P.R.S.

The K-series fluorescent radiations have been excited in plates of iron, nickel, copper and zinc by beams of exciting X-rays (λ = 0.6 A.U. $\longrightarrow$ K limits), and the efficiency of K emission determined by an ionisation method. The efficiency of K emission is also deduced for selenium, bromine and iodine, from some early measurements by Barkla and Beatty on the ionisation produced in these gases by X-rays of different wave-length in the vicinity of the K limits of these elements.

The following values have been found for the K-series quantum transformation coefficient, *i.e.*, the number of quanta of K series radiation emitted per K-ionised atom :—

Fe(26)	Ni(28)	Cu(29)	Zn(30)
0.29	0.34	0.40	0.46

0.68	0.68	0.88
Se(34)	Br(35)	I(53)

The low values found for this transformation coefficient, together with the results of other related experiments, find an explanation in the hypothesis that in some cases (conditions as yet undetermined) the excited K radiation does not escape the atom, but is "internally absorbed" in the outer electron shells, giving rise to high-speed proto-electrons. It is found experimentally that the probability of K-series emission as opposed to its internal absorption is independent of the frequency of the exciting radiation, indicating that the "internal conversion process" is a mechanism to be associated with the ionised atom itself, and is quite independent of the radiation field responsible for the initial ionisation of the atom.

The K-quantum transformation coefficient is a function of atomic number, and such that it seems probable that similar laws, relating probability of absorption to atomic number and wave-length, hold in cases of "normal" and "internal" absorption.

ELECTRONIC STATES AND BAND SPECTRUM STRUCTURE IN DIATOMIC MOLECULES. IV. HUND'S THEORY; SECOND POSITIVE NITROGEN AND SWAN BANDS; ALTERNATING INTENSITIES.

By ROBERT S. MULLIKEN.

ABSTRACT.

After a brief review of Hund's theory of molecular electronic states and band spectra, and a discussion of intensity relations and selection principles in terms of the correspondence principle; it is shown that practically all the available evidence, as embodied in previous papers of this series and elsewhere, is in agreement with the theory. The occurrence of ρ-type S terms and σ-type P and D terms is explained by the theory ,as also the existence of ρ-type and σ-type doubling. Selection rules and other relations in $^2P \longrightarrow {}^2S$ and $^2S \longrightarrow {}^2P$ transitions (including, in agreement with Mecke and Hulthén, the CH, OH, MgH, and CaH bands) are discussed. Hund's interpretation of the second positive nitrogen bands as a $^3P \longrightarrow {}^3P$ transition is further developed, and extended to the Swan bands; the apparent absence of Q branches, and other intensity relations in these bands, are explained; the rotational doubling in these bands (accompanied by alternating intensities)is interpreted as σ-type doubling. It is shown that the alternating intensities or alternate missing lines in the He_2, N_2, Swan, and N_2^+ bands can all be accounted for formally by the postulate that they are due to alternate (partially or completely) suppressed levels such that the suppressed values of $(j_k - \sigma_k)$ are always as follows: B rotational sub-states, $(j - \frac{1}{2} - \sigma_k) =$ 0, 2, 4, . . . ; A sub-states, 1, 3, 5, . . . ; here σ_k is the part of σ which is due to the orbital angular momentum of the electron, and j_k is the resultant of σ_k and the quantity m which measures the nuclear angular momentum in quantum units.—Finally, the questions of term-notation and -formulation, j values for odd and even molecules, eac., are considered. The NH β bands $(^3P \longrightarrow {}^1S)$ are briefly discussed.

—*Physical Review, U.S.A.*

ROYAL INSTITUTION.

A General Meeting of the Members of the Royal Institution was held on Monday afternoon, July 4, Sir Arthur Keith, Treasurer and Vice-President, in the Chair. Major F. A. Freeth and Mrs. Graham Rees-Mogg were elected Members.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

16,894.—Anderson, I. B.—Production of benzanthrone derivatives. June 24th.

16,964.—Anderson, I. B.—Production of dyestuff intermediates. June 25th.

16,783, 16,784.—Baly, E. J.—Manufacture of aldehyde condensation products. June 24th.

16,731.—British Dyestuffs Corporation, Ltd.—Manufacture of black and grey vat dyes.

Specifications Published.

272,567.—MacEwen, S. R.—Manufacture of solution of derivatives of dioxydiaminoarsenobenzene.

248,766.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of azo-dyestuffs.

272,580.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of azo-dyestuffs.

272,641.—Towler, W. T., and Marsh, R.—Stills or columns for the distillation of ammonia.

252,713.—Casale, Dr. L.—Process for preparing catalytically, alcohols and other oxygenated organic compounds.

Abstract Published.

270,711.—Chromyl chloride. — Permutit Akt.-Ges. — 30, Luisenstrasse, Berlin.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

PHAGURYL.

481,134.—Chemical substances prepared for use in medicine and pharmacy.—Amour Bailly, 15, Rue de Rome, Paris, France, June 29th.

OPOBYL.

481,135.—Chemical substances prepared for use in medicine and pharmacy.—Amour Bailly, 15, Rue de Rome, Paris, France, June 29th.

SANDOPTAL.

481,137.—Chemical substances prepared for use in medicine and pharmacy.—Chemical Works, formerly Sandoz, 60,Fabrikstrasse, Basle, Switzerland. June 29th.

CUIRALMIN.

480,141.—Chemical substances used in manufactures, photography or philosophical research, and anti-corrosives.—British By-Products, Ltd., Abbey House, 1, Tothill Street, London, S.W.1. June 29th.

GEN. INDEX TO THE

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SCIENCE AS A CAREER.

Science men engaged in the teaching profession are not infrequently called upon to advise concerning the future prospects of their individual students. In the case of promising pupils it may be presumed that the vast majority would recommend some branch of pure or applied science according to the type of student.

The anxious parent may well ask: "What has Science to offer?"

Major A. Church, who is well qualified to answer, contributes a valuable article on this subject in an important volume* compiled by J. A. R. Cairns, in which 36 eminent men offer their own practical solutions of the Problem of a Career.

The profession of Science presents great scope for transcendent originality and creative genius and constitutes a field of activity which has wide and beneficial influences upon mankind. The scientific aspirant who revels in study for its own sake, provided he is otherwise fitted, will find scope for such a career in one of many and various kinds of educational institutions, either at home or in the Colonies. Mr. Frank Roscoe, M.A., addresses these and others, contemplating entering the Teaching profession, in a chapter of the same volume. Mr. Roscoe explains the procedure to follow and gives sound advice which will enable those who bear it in mind to make the best out of themselves and acquire the greatest proficiency, at the same time obtaining pleasure from their results. He emphasises that not all who know their subject well are able to impart their knowledge to others. It is necessary to cultivate the ability of presenting the subject in a manner which renders easy its assimilation by the students.

The monetary rewards in the Teaching profession are never great, and even a successful professor seldom receives a stipend of more than £1,500. This position, too, is only attained by a few of the many members of university staffs. The salary of a Science Master in a secondary or technical school is very modest. This is only partly compensated by an enthusiasm for the subject and eagerness to enjoy the satisfaction of imparting it to fresh minds. Many, it is true, carry on research work on possibly some simple problem which interests them without the prospect of any financial gain.

As Major Church points out (p. 173) only *a small proportion of the yearly number of* graduates take up appointments in State-maintained institutions. Most are concerned with the application of science in which there is equal scope for enterprise and research. He mentions in how many directions a student with a science degree can look for a suitable post with the prospects of a promising career. For almost all these, however, a long and arduous apprenticeship is essential to success. The period of study is as long as for medical practitioners and members of the legal profession. The same may be said, indeed, for almost every calling dealt with in *The Problem of a Career* in which each man, eminent in his own field, reiterates the necessity for hard work, keenness and adaptability on the part of the prospective entrant. He is repeatedly warned, especially, for example, as concerns

the Stage, that fame and success are not easily achieved. Science is also not free from disillusionment.

A young investigator may do something original, perhaps, and will probably find his seniors at best polite, but cold. He will hope to gain recognition by publication. His account may not conform with editorial requirements and it will be rejected without explanation and the young man may be discouraged perhaps for ever.

Even publication will not always bring recognition. This is partly due to professional indifference and to public lack of interest in science generally. This latter, however, is a diminishing factor and it is often said by the public Press that it welcomes scientific matter. Yet how many scientific writers have had rejected their attempts to give lay readers important scientific information. Much science that is so published, fortunately, anonymously, is intended to be sensational, but is more often stupid or inaccurate, and at best, trivial, compared with what might have been said in the same space.

The volume under review contains many excellent accounts of other callings which cannot even be mentioned here. In almost all, the monetary reward is rightly given a very secondary consideration when the question of a life's work is being discussed. Few rich men are able to employ their leisure with pleasure and (mental) profit, but most men of science have such wide interests that seldom does a dull moment step into their life.

Curiously enough, the only slip in Mr. Cairn's compilation is by a successful business man, who is referring to an incident in his capacity as a member of a hospital board. An ingredient in a medicine "was *quince*, which came from the cinchona trees."

Of Science, to quote Major Church's concluding paragraphs,

"Enough has been said to show that 'blessing and honour and glory and power' are not the usual rewards even of the greatest men of science. The glittering prizes of worldlings rarely fall to their lot. There is no profession which makes greater demands upon the altruism of its coteries. At the end of a stern and arduous apprenticeship there must be a period of further work before it can become in the least degree distinctive.

Then there is the struggle for recognition by the masters. This attained, there can be no resting upon the oars or basking in the sun of established reputation. There is a constant call made for greater and greater endurance through all the disappointments accompanying frustrated hopes and ambitions following upon series after series of abortive experiments and observations. Yet, if carried out with the full recognition of the function of the scientific worker in building up step by step upon a sure foundation of ascertained and indisputable fact a newer, brighter and fuller world, there can be no career more happy or more distinctive."

J. G. F. DRUCE.

* *The Problem of a Career*, solved by 36 Men of Distinction. Edited by J. A. R. Cairns. Pp. 312. London: Arrowsmith, W.C.1. 1926. Price 7s. 6d.

INERT GASES: CHEMICAL PROPERTIES OF.

ANALES DE LA ASOCIACION QUIMICA

WORK ON THE INERT GASES.

We have received a copy of the above Journal (Vol. xv, No. 77) and have pleasure in stating that it contains amongst other matter a summary of the work on the inert gases relative to their chemical combining properties. This article is by DR. H. DAMIANOVICH. It will be of interest to note the references here which are:— Rayleigh and Ramsay, *Roy. Soc. Proc.*, 1895, LVII, 265, 296; H. Moissan, *ibid*, 1895, pp. 120, 121; Ramsay and Collie, *ibid*, 1896, LX, 53; T. Cooke, *Zeit. für Physik. chem.*, LV, 537, 46. Strutt, *Roy. Soc. Proc.*, 1912, pp. 381, 384; Boomer, *ibid*, July 7, 1925; H. Damianovich, this journal under notice, XIII, No. 67, p. 63; Berthelot, *C.R.*, 1895, CXX, 581; Berthelot, *ibid*, Jan, 1897, CXXIV, 118; Ramsay, "The Gases of the Atmosphere," 1898; Strutt, *Roy. Soc. Proc.*, 1912, LXXXVII, 381; Soddy and Mackenzie, *Proc. Roy. Soc.*, 1907, LXXX, 381; Villiard, *C.R.*, 1896, CXXIII, 377; Forcrand, *C.R.*, 1923, CLXXVI, 355; W. T. Cooke, *Roy. Soc. Proc.*, 1906, LXXVII, 128; W. Ostwald, *Zeit. für Phys. Chem.*, 1906, LV, 537; Stead, *Phil. Mag.*, Nov. 1924; Manley, *Nature*, Dec. 13, 1924, March 7, 1925, April 24, 1926; Troost and Ouvrard, *C.R.*, 1895, p. 395; Kayser and Friedlander, *Chem. Zeit. Ung.*, v, 9, p. 524; M. W. Travers, *Roy. Soc. Proc.*, 1897, LX; Runge and Paschen, *Phil. Mag*, 1895, Vol. II, pp. 297, 302; Ramsay and Travers, *Roy. Soc. Proc.*, 1897, LXI, A, 267; A. Campbell Swinton, *ibid*, 1907 LXXXIX, A,

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REPORT OF H.M. INSPECTORS ON THE PROVISION OF INSTRUCTION IN PURE CHEMISTRY IN TECHNICAL COLLEGES AND SCHOOLS IN ENGLAND.

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(*Continued from* p.39.)

CHARACTER OF THE INSTRUCTION.

As a rule the quality of the teaching is good. The high educational qualifications of many of the teachers ensure accuracy and fullness, and the matter is generally well arranged and sound. In many cases the method, also, is excellent. But all teachers are not endowed with equal judgement, nor with a natural aptitude for teaching, and all have not had the same experience. It will, therefore, be useful to indicate the more important defects which have been observed. Thus, while in the majority of cases the lectures are adequately illustrated by experiment, there are a few centres in which more experimental illustration is desirable. Even if an experiment cannot be perforemd it is often useful to set up the necessary apparatus, because

that assists the students to visualise the process. Classes in Physical and Organic Chemistry suffer more usually from this defect than those in Inorganic Chemistry. In some cases where historical treatment would add interest and intelligibility this aspect is ignored. Some teachers who have had experience with younger students cover the ground too slowly for the older students who attend evening classes, and the waste a good deal of time in endeavouring to elicit conclusions from early and isolated experiments. It should be understood that reasoning is very difficult until the students have acquired a sufficient number of facts to enable them to make comparisions. Experience shows it is better to cover the same area once at too slow a pace. Again consideration of the atomic and molecular theories is sometimes limited to the very elementary treatment which is possible in the first year, and the somewhat advanced treatment possible in the third year. It is very desirable to devote some attention to fundamental conceptions like these in each year of the course, and they should be closely associated with appropiate parts of the syllabus.

The text-book does not always serve its most useful purpose in the scheme of instruction. Teachers can save a great deal of time by instructing students to read definite portions of the book in most weeks of the course. Students need to be trained to acquire information for themselves, and the lecture hour is often more profitablly devoted to emphasising important points—creating perspective—than in conveying information which can be obtained quite easily from a book. Sometimes the students will follow the instruction more easily if they already have some familiarity with the facts or the terminolgy.

Homework exercises vary greatly in value. They are sometimes restricted to straightforward book-work and make too little demand upon thought. More attention might often be paid with advantage to calculations. The homework, like the text-book, should have a definite purpose in the scheme of teaching. For example, it may be used to secure revision, to prepare the minds of the students for a future lesson, or to fix in their minds the meaning or application of a law or principle.

Lecture notebooks vary very greatly in quality. In many cases they are excellent, in others extremely poor. Writing up notes is a very heavy task for evening students, and the labour might be considered reduced by proper use of the text-book and suitable homework exercises. Lecture notes are of more importance in the later stages when the deficiences of the text-book have to be made good.

While the laboratory exercises are generally suitable and the work well arranged, there are some schools in which an improvement would be desirable. Thus, insufficient training is given in the simple laboratory operations. The students have not enough practice in fitting up apparatus, and the importance of neatness and tidiness are not sufficiently impressed upon them. The theory of qualitative inorganic analysis does not always receive sufficient attention. In practical organic chemistry there is in some cases a tendency to give too little to preparation, and in others too little time to the study of the properties and reactions of the chief compounds dealt with in the course. Generally, more attention should be given to the study of type-reactions. In this snbject good judgement is required to secure that the students receive sufficient practice in the different kinds of exercise.

Where so much good work is being done these detailed criticisms may appear a little ungeuerous. The defects ,however, exist, and they have been recorded in the hope that they may be of service to beginners and to those who may be replanning their schemes or reconsidering their methods. The surest way to perfection lies in the recognition and elimination of defects.

EXAMINATIONS AND STANDARD OF WORK.

It will be observed that the work varies from the single isolated class in Chemistry to the organised part-time courses extending over six years, and the full-time course occupying 30 hours a week and extending over four years. So far as University and Pharmaceutical courses are concerned their standards are definite. No exact definition of the standard is possible for the instruction in Pure Chemistry given in courses for Engineering, Mining, etc. In National Certificate and similar courses, and courses in Applied Chemistry, the students are either examined by their own teachers, generally with the assistance of external assessors, or by such Bodies as the Union of Lancashire and Cheshire Institutes; the Unions of Education Institutions, which operates in the midland counties; and the East Midland Education Union. Certain local Education Authorities such as the County Councils of the West Riding of Yorkshire, of Kent and of Surrey, also conduct examinations. A few of the larger schools are also approved by the Institute of Chemistry and are entitled to prepare

candidates for the Associateship Examination. The Institute of Chemistry co-operate with the Board in the scheme for the award of National Certificates. These are of two gardes—Ordinary and Higher. The Ordinary Certificates require attendance for three years in a Senior Course of 180 hours a year, and Higher certificates an attendance for a further two years in an Advanced Course occupying the same number of hours a year. The examinations are internal, but questions are moderated and the scripts assessed by the assessors appointed by the Institute. Certain schools in the area of the Union of Lancashire and Cheshire Institutes are permitted to use the examinations of the Union, and the questions and scripts are also moderated and assessed by the Institute of Chemistry. Candidates must make a minimum percentage of attendances, and secure a minimum number of marks for home work and laboratory work. These marks count in the final total upon which the certificate is awarded. The standard for the Ordinary Certificate is rather higher than that of the Intermediate Science examnation of a University; in Mathematics it s lower; but in Organic Chemistry it covers a much wider field. The standard for the Higher Certificate is not so easy to define as in an Advanced Course a good deal of ime may be devoted to Applied Chemistry. Where no Applied Chemistry is included it ies between a pass and an honours degree.

In order to present students for National Certificates a school must be specially approved. It must be adequately equipped, the staff must be well-qualified, the conditions for admission must be satisfactory, and the course must be properly organised. Thirty-two schools have been recognised and the number is slowly increasing. Many schools have made very considerable improvements in equipment and organisation n order to obtain for their students the benefits of the scheme.

ng courses extend over six years. The fifth year is the final year of the course for the Higher National Certificate and in the sixth year students who are otherwise eligible may prepare for the Associateship examination of the Institute of Chemistry.

CONCLUSION.

It will be clear that there is a very considerable volume of instruction in Pure Chemistry in the country, and that it is being given to students with a great variety of occupation and purpose. Where it is taught in its application to Engineering, Mining, etc., it does not reach beyond matriculation standard; in the Pharmaceutical courses it rises to that of intermediate science; and in some cases higher than this, but in many of the National Certificate and University courses and in a few of the courses similar to National Certificates courses, a fair proportion of the students reach a standard which is the more remarkable considering that many of the students can only give part-time to study.

The teachers as a body are well qualified and generally competent; the accommodation and equipment are, on the whole, good; the organisation of most of the courses is satisfactory; and the defects to which attention has been drawn are the exception rather than the rule.

AMERICAN INDUSTRIAL PROGRESS THROUGH SCIENTIFIC RESEARCH.

By EDWARD R. WEIDLEIN, Sc.D.

(President, American Institute of Chemical Engineers; Director, Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.)

(Continued from Page 45.)

The Research department of the National Carbon Company, Inc., as reported by H. D. Batchelor, has produced from carbon, the most common chemical element next to oxygen, all manner of things essential to the commercial world. Among the most important of these products are carbon electrodes which range in size from huge elements forty inches in diameter, nine feet long and weighing three to four tons, for use in steel and other metallurgical furnaces, to tiny pencils of carbon one-eighth inch in diameter and two inches long, used in small dry cells. Another and perhaps not so well known form is that of activated carbon—the last defence between our soldiers and the deadly gases used in warfare.

Over a quarter of a century ago the flashlight, another form of light ,was produced by these research laboratories in recognition of the need of an easily portable electric light. Here again the original element has been developed from a dim, barely visible light to a high powered searchlight of several thousand beam candle power. These laboratories have also developed the dry cell in all forms from an original laboratory toy to one of the essential elements of the electrical industry. Investigation and research have increased many fold the electrical capacities of this product.

A recent contribution of the Union Carbide and Carbon Research Laboratories is a methane detector of two distinct types. These two devices developed by chemical and physical research provide a portable indicator which can be used to give warning of the presence of explosive gases in coal mines or elsewhere. In this instance the industrial research work of the corporation finds itself employed in a distinctly humanitarian service.

Two of the most important tools for metal working to-day are the oxy-acetylene welding and cutting torches. This equipment has been made really valuable by an unusually broad co-operative effort among several companies. The Union Carbide Company contributed through large-scale industrial research on the production of calcium carbide. The Prest-O-Lite Company developed the method of bottling acetylene dissolved in acetone, thus making the gas portable and available in smaller quantities than warrants the installation of generators. Not the least important phase of this research was that concerned with safety in the compression and transportation of acetylene and its companion gas, oxygen. as a result of which these two gases are now widely distributed by all the usual means of transportation.

In the field of organic chemistry, the Carbide and Carbon Chemicals Corporation has applied intensive research methods to isolate in pure form the various constituents of the huge hydrocarbon resources of the country and to use these materials as the basis o fintricate synthetic processes. This work is the result of intensive research begun at Mellon Institute by Dr. George O. Curme and his associates. The results of this research have made available in large quantity and at low cost a variety of commercially valuable aliphatic organic chemicals, distinct in origin as well as in application from the synthetic chemical products heretofore generally known.

A principal product of these efforts is ethylene glycol, which has been offered to industry for the first time, after having been known since the early days of chemistry only as a chemical curiosity. Ethylene glycol is now widely used in explosives manufacture and as an antifreeze material for automotive engines; it is also finding numerous new uses to supplement the inadequate supplies of glycerol and is further serving purposes entirely new in the arts. The ethers of glycol are ideal for solvents for nitro-cellulose lacquers and in the rapidly expanding lacquer industry they are introducing qualities indispensible in their nature.

The pure hydrocarbon constituents of natural hydrocarbon mixtures have also found many valuable and interesting uses. For example, ethane, propane, isobutane, and normal butane have been found to have special physical properties making them desirable as refrigerating gases.

While referring to organic solvents it is important to mention achievements of Dr. M. C. Whitaker, of the United States Industrial Alcohol Company.

The production of high grade, pure cologne spirits from molasses, which is fully competitive with the alcohol made from grain, is now done as a continuous distilling operation without the use of charcoal or chemical treatment and the accompanying expensive redistillation operation.

The U.S. Industrial Alcohol Company has solved the problem of producing anhydrous alcohol by the continuous distillation process, resulting in large production at low cost. This process is not only in use in the United States, but also in Continental Europe, England and Australia.

In the chemical field Doctor Whitaker and his associates have contributed to the development of new processes and new products in which alcohol is used as a raw material. They have developed and manufactured acetic acid from alcohol for chemical purposes on a very large scale. The manufacture of ethyl acetate by an efficient and continuous process, using all grades of dilute solutions from acetic acid, including vinegar, has also been worked out. Another accomplishment is a continuous process for the production of anhydrous ethyl acetate by an azeotropic distillation process and without the use of chemicals. By its large available production of anhydrous ethyl acetate, this company became the only American producer of large tonnages of ethyl aceto-acetate, which is now supplied to dye and pharmaceutical manufacturers.

No more striking illustration of the important relation of science to industrial progress and public welfare can be found than in the very successful research of the E. I. duPont de Nemours & Company, of which a condensed picture is presented by Dr. Charles M. A. Stine.

Among the outstanding achievements of this company's research men is the development of much safe methods of manufacture of high explosives. The development of machinery for carryong out many of the operations in the manufacture of high explosives, and the standardisation and im-

provement of the processes of manufacture, has freed this industry from many of the risks which attached to manufacturing operations of this type years ago. It is possible that the use of high explosives, while very wide and very important in the development of the industries of this country is still not so much a matter of general information as to insure an appreciation of the great progress which has been made in this industry.

Dr. C. E. K. Mees, who has contributed so much to the well-being and progress of the photographic industries, has communicated the following brief account of several research results :

"One piece of work of which everybody is now aware is the development of the Cine-Kodak process, including the invention of the reversal process and the working out of the necessary apparatus, a system by which the films daily received from amateurs at the present time can be processed. The whole of the system of amateur cinematography marketed by the Eastman Kodak Company was originated in the research laboratory.

A piece of research work which has proved very fruitful in practical results, but which has no direct relation to the work of the company, was the development of a method of electroplating rubber from latex solution. This was studied originally in order to find a method of covering photographic apparatus with rubber. The results obtained were so satisfactory and novel that the process was eventually sold to the Anode Rubber Company, Inc., for exploiting in many directions which were not originally contemplated."

Dr. E. C. Sullivan, of the Cornish Glass Works, points out some of the principal achievements in the field of glass technology.

The development of low expansion glasses used for laboratory ware, baking ware, line insulators, chemical manufacture, lamp-making, etc.

The development of potash-free lead glass for incandescent lamp bulbs when the outbreak of the World War shut off imports of potash, and later development of non-lead glass for incandescent lamp bulbs, which has made possible tank melting and manufacture of bulbs hy the automatic machine.

The development of lens design and high transmission colours for railroad semaphore signals.

Glasses for absorbing or transmitting various selected wave lengths, including X-rays, ultra-violet and infra-red. Among these products is a glass comparable with quartz glass in ultra-violet transmission.

Silicate refractories, such as tank blocks, cast in moulds from the molten material.

Representative of research done in the schools are the following investigations carried out in the University of Michigan : Heat transfer and evaporator design; gas absorption; electrodeposition of metals; mechanism of combustion in automobile engines; petroleum distillation and equipment design; season cracking of brass and factors affecting properties of metals at elevated temperatures; purification of coal gas; instantaneous carbonisation of crushed coal; causes of the disintegration of concrete and gypsum structures when exposed to moisture; dimensional changes in steel with heat treatment; and design of steel springs.

The history of industry shows clearly that within the last fifty years, and largely within half that period, manufacturing practice has advanced with a speed incomparably greater than at any previous time. Empiricism has given way to industrial research, or the application of experimental method, as manufacturing has kept pace with the advancement of science in general. Great progress in technologic knowledge has come from the infusion, through industrial research, of chemistry, physics, biology, and engineering; and technology, or systematic industrial practice, can proudly boast of many conquests that deserve to be called marvellous.

SPECTRAL ANALYSIS OF Ca, Sr, Ba AND Li.

By Kunizô Hukudu.
(*Chemical Society of Japan.*)

The procedure consists of observing salt solutions fulgurated in a special fulgurator, with the electrodes reversed, *i.e.*, the anode in the solution.

Accuracy and limit of application of this method were carefully studied and it was found that this is especially suited for the analysis of minute quantities of lithium, calcium, strontium and barium.

In carrying out this study, the author owes much to the suggestion and encouragement of Prof. Hashida and Prof. Nagai, as well as to the kind interest and care taken by Prof. Y. Shibata of the Faculty of Science of Tokyo Imperial University.

INSULIN AND ITS MANUFACTURE.

By F. H. Carr, F.I.C.

(President of the Society of Chemical Industry.)

(*Before the Royal Society of Arts, February 23, 1927.*)

Clinical Use of Insulin.

The rationale of the present treatment of diabetes mellitus with insulin is founded upon the assumption that it is desirable to rest the islet tissue of the pancreas in order to re-establish its function. For this purpose, it is obviously desirable to get rid of the abnormal concentration of sugar in the blood for the sake of the general healthy condition of the body tissues. Accordingly the dietary is adjusted to a low level and insulin is administered. In a normal individual the effects of a large dose of sugar will have ceased after 1½ hours when the excess of sugar above 0.1 per cent. has disappeared from the blood of the normal individual; indeed, the natural supply of insulin has brought the blood sugar a little below normal, and a little later the normal will be re-established by drawing upon the glycogen stored in the liver. In the diabetic the case is far different, the sugar having risen high above the level (0.19 to 0.20 per cent.) at which it escapes through the kidneys; both the flooding of the tissues with glucose and the loss through the kidneys act to the detriment of the general cell functions of the body. Nor has it fallen to the initial figure even after four hours.

In a few words, then, the basis is that in a normal individual insulin pours into the blood in such quantity and at such rate that the sugar content of the blood is well controlled. In a diabetic this is not the case, consequently at least a partial correction may be made by injecting insulin at intervals of several hours, the time of such injection being co-ordinated with the principal meals. Too much insulin produces effects which are no less serious than those resulting from a shortage; it follows, therefore, that it must be administered with great care. It is important to determine the sugar in the blood and urine at intervals, medical skill being, of course, necessary for the interpretation of the figures observed. Over-dosage with insulin produces serious symptoms demanding immediate treatment, or a fatal issue may result. These symptoms are quickly relieved if sugar or glucose is taken by the mouth.

Abundant evidence is at hand as to the wonderful results achieved by the treatment. I will content myself with two examples, the first being a case of coma to show the remarkable change in the blood content which accompanies these dramatic recoveries, the second that of a young diabetic to illustrate the wonderful improvement in general health which results from the treatment.

Very severe diabetics are likely to die in a state of coma. The onset of these symptoms had until recently been regarded as proof that death was at hand. With insulin treatment recovery from the comatose condition is not only likely, but probable; numerous cases are on record of people who have thus snatched been from the jaws of death and have been able a few weeks later to return to their homes and daily avocations.

For the record of my second example I may refer to a case described by Passmore, Raven and Poynton in *The Lancet.* A child who had been under medical treatment for diabetes for four years had become so emaciated that at eight years of age she weighed only two stone, the bones of the pelvis could be seen in their skeletal outline and the upper arms were almost unbelievably thin. With insulin treatment she rapidly regained the appearance of a bright normal child and her weight rapidly increased. After six months she weighed 3 stone 10 lbs., and went to school daily.

Banting, in the Nobel Prize Lecture, quoted 130 children treated with insulin, of whom 120 were still living; while of 164 similar children who did not receive insulin 152 were already dead.

Those who have been privileged to take part in this work have the good fortune, not accorded to every worker who contributes to important advances of science, to know that they have contributed greatly to human happiness.

Every stage in the unfolding of knowledge prepares the way for further advance. The discovery of insulin has been the starting point of many researches to which time does not permit me to refer. I should like to take this opportunity to point out that in science no national boundaries bar the road to progress. Although insulin was discovered in Canada, much of the work to which I have referred this evening has been contributed from other countries, in particular from the United States of America, from Denmark, from Japan and from this country; and quite recently the news has

come from Germany that Frank, Nothmann and Wagner, colleagues of Minkowski, the veteran physiologist, who first demonstrated the fact that diabetes is due to a defect of the pancreatic function, have discovered a chemical substance—a derivative of guanidine—which produces effects similar to, though much less intense than, those of insulin.

A Japanese investigator, Watanabe, showed that guanidine reduces blood sugar, but is too toxic for use in the treatment of diabetes. Another guanidine derivative, agmatine, which is prepared from herring sperm, has also been found to exhibit the insulin-like effect of lowering the blood sugar. It, though less toxic than guanidine itself, is also too dangerous to use.

Frank, Nothmann and Wagner, have prepared a new guanidine derivative, which is said to exercise in diabetic patients the same effects as insulin but produces them much more slowly and has the advantage that it can be administered by the mouth. Unfortunately, it is not devoid of toxic effects, and with overdosage there results loss of appetite, nausea and vomiting. Frank and his colleagues recognise these defects and consider that it is not the ideal drug for use in diabetes, but they claim that it may usefully he employed to supplement insulin treatment or by itself in mild cases. Perhaps its greatest interest is that it may prove a step in a direction which by leading chemists and pharmacologists to study other derivatives of this nature will enable them to find a true substitute for insulin.

In whatever state of purity, insulin seems always to give in common with proteoses the biuret reaction which implies that it is a derivative of $NH_2—CO—NH—CO—NH_2$. Guanidine is $HN = C(NH_2)_2$, agmatine is $NH_2C : NHNH(CH_2)_4NH_2$, while synthalin is stated to be a guanidine derivative the nature of which is not disclosed.

The elucidation of the chemical nature of insulin itself is the step to be most profoundly desired. It may be that this would involve the destruction of as much as £1,000 worth of insulin, but the priceless contribution to human happiness which the discovery of insulin represents makes even that expense appear to be but a grain of sand on the seashore. Once we understand the chemical nature of insulin, it is not too much to expect that the history of adrenalin and thyroxine will be repeated, and insulin, like the two latter, will be manufactured artificially.

THE SOCIETY OF CHEMICAL INDUSTRY.

ANNUAL MEETING AT EDINBURGH, JULY 1927.

PRESIDENTIAL ADDRESS.

CHEMISTRY IN THE PROGRESS OF MEDICINE.

By FRANCIS H. CARR.

I should court failures were I to speak upon the subject chosen for my address this morning without disclaiming at the outset any intention to attempt more than to give in bare outline an account of the general tendencies of medical research as they affect chemical industry. Pure and applied chemistry are equally necessary for progress in this field, and in important respects medicine is dependent on chemistry. Rapidity of progress will best be secured by the closest co-operation in research as carried out in academic laboratories, research institutions, and industrial establishments. Therefore I assume that others will share with me the view that the search for new remedial agents is properly the concern of chemical industry.

The chief underlying principle of medical treatment to-day consists in helping the body to produce its own curative agents. The effect of most of the medicines employed is not directly to cure, but to relieve symptoms and secure rest. There are, however, exceptionally among the older drugs a very few which do act as direct curative agents. Cinchona and ipecacuanha, for instance, contain principles—quinine and emetine—which respectively destroy the parasites of malaria and of amœbic dysentery.

THE BODY HORMONES.

As has long been recognised, in its normal chemistry the body produces active principles, contained for the most part in the secretions of its glands. These active principles present the picture of the ideal specific drug, and a study of their chemistry may be expected finally to illuminate the road of experimental investigation by giving knowledge of the particular chemical configurations and physical properties which are associated with specific physiological effects.

These natural remedies—or hormones—now regular products of chemical industry, play an important part in medical treatment, in which they are employed to rectify deficiency and also for their effects in modifying and regulating the meta-

bolism of the body. Among the best known of them we have insulin, the principle derived from the *pancreas*. By *some* delicately adjusted mechanism, insulin is continually supplied to, and used up in, the tissues of a healthy animal; and through its action the concentration of the sugar in the blood is *maintained within a narrow* range of variation from the normal.

There is also the hormone, recently separated from the parathyroid gland, which exerts a specific effect on calcium metabolism *in blood and tissues; and these is that* derived from the ovaries, which modifies the sex cycle in the female; but it would lead me too far afield were I to describe all the known hormones.

Adrenaline is the lævorotatory modification of a methylaminoethanol derivative of pyrocatechol.

This optically active substance, possessing all the well-known actions of natural adrenaline — increase in the activity of the heart, rise of blood pressure, and so forth—is now a common product of manufacture.

Thyroxine was first isolated by Kendall. Thyroxine is the di-iodohydroxyphenyl ether of di-iodotyrosine. Its constitution was recently discovered by Dr. C. R. Harington, a young English chemist who worker here for a time. He, in conjunction with Dr. Barger, discovered a method for its synthesis.

Dr. Barger is also connected with work on a third active principle present in the body, namely histamine, iminazolylethylamine, which was at first thought to be chiefly the product of the putrefactive change of protein, but which it now appears likely will prove to be produced for functional purposes in the animal body. It exerts a powerful influence upon the circulation and respiration, and it has recently been shown by Dudley and Thorpe to be present in notable amount in the tissues of the lung.

The Antitoxins.

There is another class of therapeutic substances elaborated within the animal, standing quite apart from the hormones which the body produces as it were in the daily round. I refer to principles produced in the body under the stimulus of foreign substances which are accidentally introduced—poisonous bacteria, for example. These principles—known as antitoxins—are, like the hormones, marvellously potent substances. Naturally, to get to understand their chemical nature would be a great advance.

Their action in the body may be contrasted with that of the well-known chemi*cal substances or antiseptics which can be* shown readily to destroy bacteria grown in a culture tube. Generally speaking, these chemical disinfectants are found to damage the cells of the host as well as the bacteria. The *bactericidal substances* which the animal body produces when attacked by bacteria, on the other hand, do not exercise any deleterious effect on the tissues of the animal. To effect disinfection externally is very different from doing so internally, and we may succeed in disinfecting wounds by these powerful chemical antiseptics, though even for that purpose it is now the practice to select substances which are found to effect the least damage to the tissues, because the bodily defences thus suffer least interference. For this reason certain dyes, of which acriflavine is an example, now occupy important places among wound antiseptics. We cannot, however, disinfect the blood-stream by injecting the ordinary chemical antiseptics, because they damage and weaken the healthy cells of the body.

The formation of antitoxins is well exemplified by considered the case of the vegetable toxin present in the seed of Ricinus communis. Ricin is very poisonous—one-thousandth of a milligram per kilogram of body-weight injected subtaneously proves fatal. If much smaller doses are repeatedly administered to an animal it gradually acquires tolerance, so that it will presently be unaffected by doses 5,000 times as great as that which would previously have proved fatal. This acquired immunity is due to the formation of an antagonistic substance which is found in the blood. Its existence is demonstrated by the fact that if the serum from an animal rendered immune in this way be transferred to another animal, the latter also acquires this tolerance without having itself received any doses of the toxin.

It is self-evident that the best therapeutic agency is likely to be one which most nearly imitates nature, therefore Ehrlich regarded it as a promising direction for experimental attack on the problem of producing new therapeutic compounds to follow the procedure indicated by our knowledge of these chemical changes in the living organism.

Perhaps even more important than the new therapeutic agents to which Ehrlich's theory directly gave rise is the fact that this achievement established the value of joint work in chemistry, parasitology and physiology.

Ehrlich's assumption that the drug usually acts by direct combination with the parasites has not been supported by the later studies of these arsenic derivatives and other chemotherapeutic agents. Dale, for instance, points out the difficulty in explaining without unwarrantable assumptions why it is that certain parasites in the blood of a mouse become more resistant to arsenical drugs after the animal has received a number of incompletely effective doses, whereas if they are then transferred to rats the same organisms again become susceptible. As Dale points out, these and other considerations indicate that the host is an essential participant in the cure. More recently, Voegtlin has shown that a period of time elapses between the injection of these arsenic compounds of the type of salvarsan (*i.e.*, the arseno-compounds) and the development of their maximum toxic action on trypanosomes. This he considers to be associated with the hydrolytic oxidation-reduction processes of the cell which were demonstrated by the brilliant work of Hopkins to be due to a cystine compound, glutathione, a common constituent of cells and one which is capable of undergoing the reversible reaction RS.SR + H_2 is in equilibrium with 2R.SH.

Voegtlin considers that the arsenicals owe their action to interference with the normal oxidation-reduction processes of the cell, since he finds that the simultaneous injection of glutathions and the arsenical depresses the toxic action of the latter. His experiments are consistent with the view now generally accepted that animal tissues reduce the arsinic acids and oxidise the arseno-compounds to the intermediate arsenious oxide

$$R.AsO_3H_2 \longrightarrow R.AsO \longleftarrow R.As:As.R$$

King and his colleagues have made observations which are in support of this. In the course of much valuable and painstaking work they have prepared over 150 new arsenical compounds of varying constitution in the hope of discovering the particular groups or orientations which are most favourable to a high ratio of trypanocidal action to toxicity. King has been led to the view that when arsenoxides are active *in vitro* but inactive *in vivo*, this is due to an inactivation of the substance by some body mechanism.

Other Organo-Metallic Derivatives.

Among other organi-metallic compounds, those of antimony, lead, bismuth, mercury and gold claim consideration. This field, hitherto little explored, presents many alluring prospects. The salts of all these metals have found useful application in medicine, but their administration is attended with risks on account of their directly toxic effects.

Dyes Used in Therapeutics.

From Ehrlich's conception of the affinity of antitoxins for the cells of invaders we may readily perceive how he came to study the use of dyes in therapeutics; for it is the inherent nature of dyes that they have affinities for, or, in other words, are adsorbed by, vegetable and animal cells. That they have a selective action on particular structures is shown by their use in microscopy, whereby different dyes are made to stain different constituents of the same cell. They also have a selective action on particular bacteria, as exemplified by the so-called Gram-positive and Gram-negative bacteria, which are distinguished by finding whether they are stained by gentian violet or not. A particularly interesting example of selective action is that of certain racemic dyestuffs, which can be resolved into their dextro- and lævo-constituents by soaking wool in them, by which process the dextro-isomerides are preferentially adsorbed.

It does not follow, of course, from these considerations that dyes are useful in therapeutics; an organism which is stained *in vitro* may not be similarly affected in the animal body, and the mere fact of staining does not necessarily imply the destruction of the parasite.

A dye has two chief properties : it is adsorbed by fibres and absorbs radiant energy from that part of the spectrum which affects the retina of the eye. There is no reason to suppose that a dye produces any particular antiseptic effect, because of this colour property; but a compound which attaches itself selectively, as a dye does, to particular cell constituents, may also contain chemical groupings which confer the requisite bactericidal or trypanocidal properties. On this view the colouring property of the dye is not the significant one, but its capability of adsorption is a property of particular moment. This quality is no doubt possessed by many colourless substances, only one cannot so readily detect it in them. It is thus an accident that dyes have hitherto received chief attention.

The study of the dyestuffs has been largely directed to the treatment of diseases due to protozoal infections. Infected mice or rats are injected with the dye under test to see whether non-toxic doses exert a curative effect on the particular infection. In this way very many dyes have been

tested against known protozoal diseases, and some useful compounds have been discovered.

Other derivatives of acridine have been discovered which are suitable antiseptics: 6 : 9-diamino-2-ethoxyacridine, known as rivanol, and 6 amino-3-dimethylamino-2 : 7 : 10-trimethylacridinium chloride, known as flavizide. Both of them are powerfully bactericidal to staphylococci and streptococci, and do not depress the body's own power to resist these bacteria.

It is not unreasonable, for instance, that we should look forward to ultimate achievements such as the discovery of a compound which will eradicate the germ of tubercle from the body. For such a purpose the compound must possess the required adsorbent property and in addition must be continuously distributed through the tissues for a long period of time at a concentration which destroys bacteria. It is unlikely that without long-continued action all the bacteria can be destroyed. Our difficulty is in finding compounds which leave the body unharmed and yet act for the long period of time that is required to destroy bacteria which pass through resistant stages. In securing this continuous distribution the body mechanism appears to play an important part.

Quinoline Derivatives.

Many of the vegetable alkaloids employed in medicine are derivatives of quinoline and *iso*quinoline, as, for example, quinine, morphine and strychnine. Quinoline derivatives therefore provide a promising field for research. Much time and trouble have been expended during the past twenty years in the endeavour to find a substance which will displace quinine in the treatment of malaria, and numerous new quinoline derivatives have been prepared with this end in view. It is only quite recently that real success has been attained ,through the introduction of a new technique of testing. Formerly the compounds were tested for their action upon amœbæ *in vitro*, and on this test the effects of adding different groupings to the quinoline and *iso*quinolime nucleus have been classified and the effect of complete and partial hydrogenation has been studied, without, however, leading to the discovery of any useful antimalarial agents.

One cannot help suspecting that in this work usefully active substances may have been overlooked through the lack of means for esting them on malaria in animals. Until recently it has not been possible to infect laboratory animals with malaria or any allied infection. A parasite of bird malaria has now been found which, although not identical with the human malarial parasite, reacts in a similar way to therapeutic agents. This discovery has made it possible to test the effects of these quinoline compounds on infected canaries.

As a first-fruit of this new technique there has been recently introduced a new quinine substitute, named plasmoquin, the composition of which is not disclosed beyond the fact that it is an alkylamino-derivative of 6-methoxyquinoline. This compound is said to effect the destruction of the crescent form of the malarial parasite more rapidly than any other known therapeutic agent. Chemists will be eager to learn its constitution, for it seems likely to provide an interesting example of a substance having part only of the structure of an active alkaloid—quinine—yet possessing its chief physiological property.

The search for new drugs has led to useful deductions as to the effect which the varying of certain groups has upon the anæsthetic, narcotic and mylriatic properties of compounds. It cannot be said of any of these generalisations that they enable us accurately to foretell physiological properties from an inspection of structural formulæ. They do enable us, however, in many cases to choose the type of structure best worth submitting to experiment.

Progress lies in the direction of biochemistry and more effective working contact between individuals in chemistry, bacteriology, physiology and clinical medicine. We need to multiply a hundred times discoveries like those relating to the oxidation and reduction phenomena in the tissues, to the constitution of glutathione and of thyroxine. As these results become known, and with the fuller development of experimental technique, we need bold hypotheses like that of Ehrlich so as to open up new avenues of thought and work.

It is a worthy ideal that chemical industry should aim at joining in a united effort to promote progress by the freest and frankest co-operation and interchange of thought with those engaged in this research, whether it be with rivals in industry or with academic institutions. Chemists become ends, and there is a great multitude of research workers in chemical science who give thought and energy unreservedly to the furtherance of knowledge which they do not even remotely expect will bring to them individual gain. I would claim that those who pass out from research

laboratories to serve our industry do not willingly nor entirely abandon this attitude to human service. On the contrary, these men retain a genuine interest in the science, and this interest, and not mere earning, provides their greatest spur and excitement to effort. The necessary of earning need not divert them from serving an ideal.

General Notes.

MEXICAN CHARCOAL AND INDUSTRIAL WASTE.

Gas for cooking purposes is an unknown commodity in this country. Some years ago a British company made an effort to introduce gas for lighting, domestic, and industrial use, but due to adverse conditions the works went as far as installing the mains, and some branching into private houses was done only, and the enterprise could not be carried farther.

As a general rule, charcoal from dry distillation of wood is used in the homes as a source of fuel. The consumption of charcoal for domestic use reaches an amazingly high tonnage yearly.

This commodity is manufactured in a rather primitive way by the natives who do not know of the highly valuable by-products ,such as wood alcohol, acetone, acetic acid, that go to waste in the process. If we consider the amount of charcoal used and the number of years it has been in use without technical intervention to utilise its by-products, a rough estimate would show that many millions of gallons of the volatile constituents of wood, widely used in industry, have gone to waste.

Due to the fact that these primitive charcoal manufacturers, which can be numbered by thousands all over the country, have no operating expenses whatever, they can sell their product comparatively cheap,—*i.e.*, fluctuating between 3 and 5 cents per kilo (7 to 11 cents Mexican money). However, it seems possible that if the same wood were treated with modern retorts to utilise its volatile constituents, charcoal would be the by-product, and the organic solvents obtained would establish an important industry.—*Industrial and Chemical Engineeering.*

CANADA'S OUTPUT OF IRON AND STEEL PRODUCTS WORTH

$500,000,000 IN 1926.

Production of the iron and steel industries of Canada in 1926 was valued at almost half a billion dollars, according to preliminary figures now available. That the business of the year was highly satisfactory as compared with recent years is evident from the fact that all groups showed gains, and in the aggregate an advance of 23 per cent. was made to a total value of production of $496,376,260, the highest figure since 1920.

Of the thirteen groups into which plants in the iron and steel industry are classified, the automobile industry stood first with the selling value of products estimated at $183,598,456, a gain of almost 28 million dollars, or 21 per cent. over the preceding year. The railway rolling stock group in second place at $72,460,962, had a gain of 37 per cent.; castings and forgings gained 10 per cent. to $68,207,976; the primary iron, steel ingots, direct steel castings and rolled products, gained 17 per cent. to $41,257,070; sheet metal goods, 14 per cent. to $39,190,724; industrial, household and office machinery, 26 per cent. to $38,369,454; agricultural implements and machinery, 29 per cent. to $31,918,734; hardware and tools, 27 per cent. to $22,648,667; wire and wire goods, about 8 per cent. to $16,657,865; automobile parts and accessories, 24 per cent. to $13,919,379; boilers, tanks and engines, 17 per cent. to 65,320,685; and the bicycle industry, $1,452,437.

CANADA TO HAVE NATIONAL RESEARCH LABORATORIES.

To the end that Canada's natural resources may be developed to the fullest possible extent, that Canadian industries may be placed on the most efficient basis, and that the waste products of industry may be utilised, the Dominion Government has, it is announced, decided upon an important expansion of the activities of the Honorary Advisory Council for Scientific and Industrial Research. It is proposed to establish at Ottawa, national research laboratories, under control of the Council, which will undertake standardisation work of all kinds as at the Bureau of Standards, Washington, and the National Physical Laboratories in England and in which pro-

vision will be made for the carrying out of research by private firms. The aim of the Government is to co-ordinate all the forces now engaged in industrial and scientific research.

ALBERTA BITUMINOUS SAND FOR PAVING PURPOSES.

An extensive deposit of bituminous or asphaltic sand occurs in the vicinity of Fort McMurray in the northern part of the Province of Alberta, Canada. From time to time, during recent years, references to this deposit have appeared in official publications issued by the Mines Branch, Department of Mines, Ottawa.

Commercial production from the above deposit has not so far been undertaken. Until quite recently the absence of adequate rail transportation and financial conditions which have prevailed in Western Canada during the years immediately following the War have militated against such development. It now appears, however, that commercial development may be anticipated in the near future. The use of the bisuminous sand for roadmaking purposes has meanwhile been under consideration by the Mines Branch as well as by the Research Council of Alberta. In 1915 the first street surfaces—including bitulithic, bituminous concrete, and sheet asphalt mixtures—were laid in Edmonton, Alberta, with entirely satisfactory results.

THE TITLE "CHEMIST."

The Journal and Proceedings of the Institute of Chemistry reports :—

"Mr. Vincent H. Kirkham, Honorary Corresponding Secretary, has reported that the Legislative Council of the Zanzibar Protectorate has lately passed a decree to regulate the dispensing and sale of drugs and poisons, in which only the word "druggist" is used to define a person who mixes, compounds, prepares, dispenses, or sells any drug or poion. The decree comes into operation in the Protectorate on July 1, 1927.

Mr. Kirkham, who is Director of Agriculture and a member of the Legislative Council ,spoke in support of the Bill, but moved an amendment, which was adopted, for the deletion of the word "chemist" from the Bill. He said that it was only among English-speaking people that the confusion had arisen about the meaning of the word. He gave a short history of the use of the word, showing that in the year 640—according to one way of calculation—the Arabs overran Egypt, one name of which was Qimia. They found at Alexandria a university where many things were studied. The Arabs were interested in the studies of the men who were trying to make gold out of baser metals. This study they called Al qimia. The spread of Arabian culture westward along Northern Africa at length reached Spain, and, in the thirteen century, universities were established there, where the Arabian culture, with its alchemy, algebra, and other sciences began to flourish, while Greece and Rome were falling into barbarism.

The old alchemists whilst searchiug for a method of transmuting base metals into gold found out many things about the composition of matter, and eventually the science of chemistry was evolved from these efforts. Those versed in this science were called "chemists."

It was extremely difficult for an Englishman to realise the incongruity of applying this title to the person who compounded a cough mixture or sold rat poison, because for sixty or seventy years the term has been thus misused. It would be better appreciated, Mr. Kirkham said, if he drew parallels : for instance, if one spoke of buying a ton of coal from a geologist, the incongruity would be apparent, so also if one referred to a greengrocer as a botanist, a butcher as an anatomist, or a fishmonger and poulterer as an economist biologist; and it would be more polite than accurate to designate as a zoologist the man who had sold you a pup.

Mr. Kirkham then referred to a body—the Institute of Chemistry—whose members were actually "chemists," because they were versed in the science of chemistry, and pursued the study of the composition of matter and research after means of making new substances. It was being felt even in England that the term "chemist" should be applied only to those to whom it properly belonged.

PROCEEDINGS AND NOTICES OF SOCIETIES.

GEOLOGICAL SOCIETY.

The following paper was read at the meeting held on May 25 :—

The Old Red Sandstone of the Bristol District. By FREDERICK STRETTON WALLIS, M.Sc., Ph.D., F.G.S.

The Old Red Sandstone sediments in the immediate neighbourhood of Bristol have been examined and the results recorded from stratigraphical, petrographical, and palæontological standpoints.

Although the total thickness of these deposits is now estimated at 3,000 feet, the faunal contents give evidence of the presence of beds of Upper Old Red Sandstone age only, and no apparent unconformity in the strata or mineralogical break has been detected.

Every gradation of deposit between the following types can be found :—Coarse- and fine-grained sandstones, conglomeratic sandstones, siltstones, quartzites, cornstones, pure limestones, and conglomerates. True marls and shales are absent.

It is shown that the material was derived from a pre-Cambrian massif consisting of gneisses, mica- and quartz-schists with abundant quartz augen and volcanic or intrusive rocks, together with a sedimentary series of arenaceous and calcareous (largely silicified) types.

This source was situated north-west of Bristol, and its rocks are shown to have been similar in character to those of the Mona Complex, and especially to the Gwna Beds of that formation. It is not, however, necessary to postulate that the material came from 'Anglesey' of the present day. Unfortunately, we do not know even the approximate dimensions of the original complex, and the material may have come from some part of it exposed in Old Red Sandstone times, but now covered by later deposits.

The sediments were transported by a great river, which, flowing through a country affected by heavy seasonal or spasmodic rainfalls, finally reached the sea by a broad delta in the neighbourhood of the Bristol district. Lagoons also formed important physiographical features near the coast.

NOTICES OF BOOKS.

Kolloidchemische Technologie. Ein Handbuch kolloidchemischer Betrachtungsweise in der Chemischen Industrie und Technik. Edited by PROF. R. E. LIESEGANG and others. Pp. VIII + 1047. Dresden and Leipzig : Th. Steinkopff. 1927. Price, paper 66 marks; bound, 70 marks.

Prof. Liesegang is perhaps one of the leading scientists engaged in the important study of colloidal phenomena. We are indebted to him, moreover, for his comprehensive compilations, among which the volume under review will occupy a prominent place in the future. It will be consulted and quoted by all concerned with collolids—a subject whose number of devotees are increasing very rapidly.

Reference is made to thousands of original papers and the great work of correlating all this matter has been very successfully accomplished.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

17,220.—Caro, N.—Nitric Acid. June 28th.

17,469.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of hydrogen peroxide. June 30th.

17,078.—Chloride Electrical Storage Co., Ltd.—Manufacture of lead oxide. June 27th.

17,215.—Hall, R. E.—Filtration of alkaline waters. June 28th.

17,091.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of vat dyestuffs. June 27th.

Specifications Published.

272,970.—Cooper, C., Henshaw, D. M., and Holmes, & Co., Ltd., W.C.—Separation of water from mixtures of ammonia and water vapour.

246,181.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of preparations of diazo-salts for dyeing and printing.

272,996.—Stalhane, O.—Process of and apparatus for manufacturing cyanides.

273,043.—British Dyestuffs Corporation, Ltd., and Hailwood, A. J.—Electrolytic desulphonation of anthraquinone sulphonic acid.

Abstract Published.

270,651.—Benzyl benzoate. — Canadian Electro Products Co., Ltd., 88, Craig Street West, Montreal, Canada (Assignees of Matheson, H. W., 88, Craig Street, West, Montreal, Canada).

Benzyl benzoate is obtained by treating benzaldehyde with an alcoholate of aluminium (aluminium ethoxide or butoxide) as catalyst, preferably in solution in an ester corresponding to the aldehyde. The catalyst may be poured into ethyl acetate, ethyl butyrate, butyl acetate, butyl butyrate or benzyl benzoate or it may be added directly to the benzaldehyde, or the benzaldehyde to it. In an example the molten catalyst is added to benzaldehyde and the temperature is allowed to rise, the product being distilled in a vacuum.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

IRIPHAN.

478,808.—Chemical substances prepared for use in medicine and pharmacy.—Ernst Karl Theodor Laves, trading as Dr. Ernst Laves, Hildesheimerstrasse 173, Hanover, Germany. July 6th.

RADIOSTOLEUM.

481,280.—Chemical substances prepared for use in medicine and pharmacy.—The British Drug Houses, Limited, 16 to 30, Graham Street ,City Road, London, N.I. July 6th.

ANTIMOSAN.

481,435.—Chemical substances prepared for use in medicine and pharmacy.—Bayer Products, Limited, 31 to 34, Basinghall Street, London, E.C.2. July 6th.

ORARSAN.

481,226.—Chemical substances prepared for use in medicine and pharmacy.—Boot's Pure Drug Co., Ltd., 37, Station Street, Nottingham. July 6th.

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A SELECTIVE DISPLACEMENT OF 0.0153A IN X-RAY SPECTRAL LINES. PART IX.

By F. H. LORING.

In the previous part of this study (VIII) the paragraph beginning as herebelow—on page 18—is incomplete. It is here completed with additions which are supplementary to the evidence that Δ_a is a fundamental quantity, now supposed to be very near to the value 0.01525165.

The He line λ 3208 may be closely evaluated thus : $21\Delta_a \times 10^4 = 3202.8466...$ Similarly, $3072\ \Delta_a \times 10^2 = 4685.3070$ . . This line may be compared with the other "first even" line of He, when it is evaluated by taking $1792\Delta_a \times 10^2 = 2733.0957$ . . ., giving a difference of $128\Delta_a \times 10^3 = 1952.2112$ . . . It will be seen that this difference multiplier is an integral multiple of 8, which, in this respect, is in agreement with the similar difference values involving whole numbers *8, 16, 24, . . 128. This agreement tends* to show that Δ_a is closely or properly evaluated, and the calculations carried well into the decimal region were perhaps justified. It seems to show also that the "displacement" of the "first" lines of each "series" is a whole-number multiple of Δ_a. Comparing Paschen's determinations (*Annalen*, 1916, L, 901) with these values, however, does not reveal absolute agreements. The basic value by selection is as near as can be expected for the measured wave-length was 4685.307_2, the inferior 2 being uncertain. On this account it was thought best to increase Δ_a by adding a figure to the tail of the decimal figure, but this is an arbitrary step and may be ignored. It is important, nevertheless, to get the value as near perfect as possible on account of the large whole-number multipliers used. Comparing the above values with the fine measurements of Paschen reveals a difference in two cases of about 0.1A unit, Paschen's fractions being .952 aud .189, as against .8466 and .0957. The importance of refining the value (Δ_a) is thus made evident.

There are other ways of testing the constants as given on page 17 (Part VIII) and some of these are given here.

It is necessary again to apologise for extending the calculations so far into the decimal region; but, at least it may be taken as a safeguard to insure no errors arising from a neglect of this precaution. As Lord Birkenhead has said, "Science is *both exact and exacting," but the figures* must not be thought to be exact because they are given to the *n*th decimal place. This is perhaps obvious. The values are only seemingly consistent according to the scheme. Some extensions are possible as will be seen from the following.

Taking $e = 4.779 \times 10^{-10}$ as before, $e/m = 1.767488 \times 10^7 \times c$, also as before, the mass (rest mass) of the electron comes out at $9.0189218 \times 10^{-28}$ gram.

The ratio of the mass of the electron to the mass of the hydrogen atom (nucleus) can be calculated from the known equation :
$4R_H - [(H_a/He_a).4R_{He}]/(4R_{He} - 4R_H) = 1847.0871$;
when $R_H = 109677.72648$, $R_{He} = 109722.13929$, H_a = atomic weight of the hydrogen atom, and He_a = atomic weight of the helium atom—neglecting the masses of the non-nuclear electrons contained in these respective atoms. On account of these electrons influencing the calculation, since it is *atomic nuclei* that are concerned in the above equation, the atomic weight of hydrogen may be taken on the low side, *viz.* : 1.00776. In the case of the atomic weight of helium, it is not known in the third or fourth decimal place accurately—where presumably the electronic mass begins to affect the value—so no other figure than 4 can be taken. The ratio in the above calculation was therefore : $H_a/He_a = 0.25194$.
The gram mass of the H atom (H_m) can now be determined ,since it is 1847.0871 times the gram mass of the electron as given above. H_m comes out at $1.6658734 \times 10^{-24}$ gram. This value is perhaps a little high in and beyond the third decimal place as it should represent the mass of the H nucleus; but, as this value into e, then divided by c gives 9569.0583, it is possible to compare the latter value with the generally-accepted one. Since 0.01118 gram of silver is deposited by one absolute unit of electricity the following equation applies to hydrogen, here inserting the figures given by Millikan in his " The Electron."

$$e/H_m = (1/0.01118) \times (107.88/1.008) = 9573 \times c.$$

If, however, the value 9569.0583 is nearer to the true value, then tbe atomic weight of silver would have to be lower when the other values are kept the same.

This lower value by calculation would have to be 107.83793; but, to this value should evidently be added (as a final operation when working in the direction thus indicated) the masses of the electrons exterior to the nucleus of the silver atom to bring the value to the experimental one, *i.e.*, make up the atomic weight on, of course, the O = 16 basis.

The calculation can therefore be extended. 1.008/1847.0871 = 0.0005457, this being the atomic weight of the electron (oxygen = 16). As the atomic number of silver is 47, this number represents the number of electrons outside the nucleus (= extranuclear electrons). Therefore, 47 × 0.00054572 = 0.02564884. 107.83793 + 0.02565 = 107.8636. This value does not agree with the present-accepted atomic weight of silver, *viz.* : 107.876; or, 107.88 which is the value usually taken. H. L. Riley and H. B. Baker (*Journ. Chem. Soc.*, 1926, October, p. 2510) have obtained a low value for silver, *viz.* : 107.864 *plus* or *minus* 0.0013. Riley and Baker's determination has been criticised in *Nature* by Brauner. It is evident from a most casual observation that a practically exact agreement in this case carries no weight whatever, because some of the factors entering into the calculations are not sufficiently refined to make a final value anything more than approximate, yet there is a marked tendency for the calculated atomic weight of silver, by the method of this study, to be distinctly low when compared with the classic value of Richards and his co-workers.

The following from Campbell's " Series Spectra " (cited fully in Part VI) p. 50, is of interest in connection with the above attempt to evaluate the atomic weight of silver etc. " On the other hand, this ratio of the masses of a hydrogen nucleus and an electron can be calculated from $e/m = 5.31 \times 10^{17}$ and $e/H_m = 9570 \times c$—given by the electrochemical equivalent of hydrogen [see above]—the result is the value

$$H_m/m = (e/m)/(e/H_m) = 1850^*.$$

The agreement [compared with the other method of calculation as also used by the present writer above] is perfect. It is rather too perfect and is partly due to the mutual cancellation of small experimental errors. For atomic weights give, not the ratio of the nuclei, but the ratio of the nuclei with their electrons—if it is true that the weights of nuclei and electrons are additive. It is unnecessary to enter into these refinements ,but it should be noted that this method is probably the most accurate at the present time for determining H_m/m and e/m. The value for the latter turns out to be $1.7686 \times 10^7 \times c$. It is worthy of note that the greatest source of experimental error is not the spectroscopic determination of R_H and R_{He}, although the whole difference $4R_{He} - 4R_H$ is only 4 parts in 10,000. R can be measured to 4 parts in 10,000,000—such is

* Using the constants as evaluated in this study the value is *1847.0871*, which follows of necessity in this case.—F. H. L.

the extraordinary sensitiveness of modern interference methods and such is the accuracy of the theoretical equations. The greatest error is in the ratio M_{He}/M_H [atomic weights. Most books of reference give e/H_m = 9647; but the value assumes that the atomic weight of hydrogen is 1 relative to Ag = 107.88; it is really 1.008." The present writer has made some slight alterations to keep the text more uniform, but the original can be consulted if any doubt arises.

Adhering to the basic atomic values of this study Avogadro's constant $1/H_m$ = 6.002857×10^{23}.

The table of constants given on page 17 of the previous part (VIII) may now be extended Δ_a being as before—see opening part. It will be seen that the calculations are such as to give 8 figures in most cases; but, of course, they are not final values though they may be in true correllationship, as already explained.

(12)* Δ_H by correction (?) = 0.365086 (not used here).
(13)* $R_{inf} = c\Delta_H\dagger \times 10^{-3}$ = 109737.20792.
(14)* $R_H = R_{inf}$ $39\Delta_a \times 10^{2}$ = 109677.72648.
(15)* $R_{He} = R_H + 2912\Delta_a$ = 109722.18929.
(16) $m = 9.0189213 \times 10^{-28}$ gram.
(17) $H_m = 1.6658734 \times 10^{-24}$ gram (H nucleus).
(18) H_m/m = 1847.0871
(19) $e/H_m = 9569.0583 \times c$
(20) Atomic weight of the electron = 0.0005457‡ (O = 16).
(21) Atomic weight of silver = 107.8686§ (O = 16).
(22) Avogadro's constant = 6.002857×10^{23}.

* See Part VIII.
† As previously used and derived from Δ_a.
‡ This value may be a little high as 1.008 was taken for the atomic weight of hydrogen.
§ This value, as already indicated, is calculated from basic constants, but some of these are not known experimentally with great accuracy, so that the decimal-place figures become more and more uncertain in passing to the right. This remark *applies to all the values, but the almost-full figures are given as a result of calcula*tion to eliminate all errors due to calculation.

Since publishing the values in Part VIII the writer has had all the calculations checked with the result that they are all accurate; but, the value " 0.36603 " on page 18 should read: 0.3660386. This makes the agreement sought practically exact—almost too exact, as absolute agreement would be a chance coincidence, since the values compared were derived from independent sources*.

It should be borne in mind that the object of this study is to find out whether the Δ_a value is a real or significant entity of importance. This has lead to the trying out of the atomic constants, so to speak, by using Δ_a *as a sort of basic factor.* The results on the whole seem to confirm the belief that the quantity in question, if it may be called a quantity, is fundamental.

It must be remembered that each correlation taken as an isolated circumstance is not good enough—it might be a chance coincidence; but, when the relations can be extended, with few exceptions, they seem to give strong support to the value Δ_a not being of fortuitous origin.

No theory can be advanced, but in one way this is a strong point, as theories often change while the numerical values remain.

This series of studies is now concluded under the present title—except for a possible errata or amendment to follow.

The writer is grateful (1) to the Editor of the *Chemical News* for giving space for so extended a study; and (2) to Mr. E. A. Stevens for checking many of the calculations involved.

* There are several minor corrections: Part VII, p. 385, 14th line from bottom left, XXXVIII should read XXVIII. On p. 387, 13th line from bottom left, intial should read initial. In referring to e/m = 1.769 on p. 388, 2nd line from bottom, this value was not derived exactly from the other constants quoted, but was cited by Paschen in connection with Flamm's equation (see Part V).

General Notes.

DATA IS OR DATA ARE?

In one of the leading scientific journals there is an argument on the question implied by the above title. Dictionaries give Data *plural* and Datum *singular*.

The word is, however, used in a collective sense in place of the word *group*, or *collection of facts*, often expressed in figures. In that case, *Data is* would seem correct. We say, for example, " referring to the data on page . . . it has been accurately compiled." A very careful writer might so choose his words as to avoid this difficulty, but no serious mistake can be made either way. In fact *Data are* is not euphonious and hence it is sometimes avoided, so that *Data*, like *Apparatus*, is used in the collective or group sense. Apparatus is, of course, either singular or plural; and, likewise, Data by usage may be regarded in much the same way.

The argument does not end here, for one could say Data represents particulars, or sets of figures; and, therefore, particulars *are*, or figures *are*, would have to be used. However this may be, there is a good deal to be said in favour of Data *is* for the reasons first given above.

THE BOARD OF TRADE.

MERCHANDISE MARKS ACT, 1926.

The Board of Trade have referred to the Standing Committee appointed by them under the Act applications for Orders in Council to be made requiring indications of origin to be given in the case ow imported pottery; furniture and cabinet ware; surgical, medical, dental and veterinary instruments and appliances, and aseptic hospital furniture; motor and cycle rims; and gloves of leather or of fur, and fabric gloves.

Representatives of any interests substantially affected by any of the applications referred to in the above announcement who desire to be heard in opposition at the public enquiry, which will be held later by the Committee, are requested to communicate with the Secretary, Mr. E. W. Reardon, at the New Public Offices, Great George Street, London S.W.1., with the least possible delay, and, if practicable, not later than July 29.

SPAIN'S MANUFACTURING INTENTIONS.

The year 1926, taken as a whole, probably moved a step further towards normalising the disorganisation following upon the post-war period, but it is clear that Spain has every intention, if it is by any means possible, of becoming a manufacturing country and thus achieving a fair measure of industrial independence. If success is attained it will be all the more noteworthy since Spain has always been considered an agricultural rather than an industrial country.

METALLURGICAL INDUSTRIES OF THE NIAGARA PENINSULA.

Pig iron is made at two points in the Niagara Peninsula. At Port Colborne, on Lake Erie, the southern terminus of the Welland Canal, is located the blast furnace belonging to the Canadian Furnace Company. The plant includes a single stack 82 feet high, 19.5 feet in diameter, provided with four two-pass stoves each 80 feet high and 20 feet in diameter. The capacity of the plant is about 125,000 tons of pig iron per annum. Connelsville coke and lake ores are both imported. The principal products are foundry, Scotch, Bessemer, and malleable pig.

The second plant, that of the Steel Company of Canada, is located at Hamilton on Burlington Bay. There are two stacks at this plant, one being 73 feet high and 15 feet 8 inches in diameter, the other being 90 feet high and 20 feet 4 inches in diameter, 8 McClure three-pass stoves, and five two-pass combination stoves. The annual capacity of the plant is about 290,000 tons, and the output comprises various grades of basic, foundry and malleable pig. This company also operates an extensive steel plant, rolling mills, and by-product coke ovens.

EMPIRE MINING CONGRESS BULLETIN.

Members of the Empire Mining and Metallurgical Congress, which meets in Canada in August, may find it to their advantage to obtain information in advance concerning the mining districts in which they are specially interested, and which they will visit on the tours that will be made across the country after the session at Montreal. The Federal Deparment of Mines at Ottawa is pleased to proffer its services in this connection.

For those attending the Congress a handbook entitled " Canada—Geology, Mines and Metallurgical Industries," is being prepared in the offices of the Department to be used on the tours. This is a volume of some two hundred and fifteen pages which will present facts relating to the history of the mining camps to be visited, the geology and nature of the ore deposits, mining practice and metallurgical treatment, and will be distributed from the offices of the Congress in Montreal and to delegates on R.M.S. " Alaunia " *en route* to Canada.

Full information can be obtained from the Industrial Branch, High Commission for Canada, Trafalgar Square, London, S.W.1.

HOME OFFICE REGULATION AS TO BISULPHIDE OF CARBON.

Draft Bisulphide of Carbon (Conveyance) Regulations Proposed to be made by the Secretary of State in Pursuance of Section 9 and the Third Schedule of the Petroleum Act, 1926 (16 and 17 Geo. 5. c.25) as Applied by Order in Council Dated November 5, 1926 (a).

In pursuance of Section 9 and the Third Schedule of the Petrolenm Act, 1926, as applied by Order in Council dated November 5, 1926, I hereby make the following regulations amending the Bisulphide of Carbon (Conveyance) Regulations, 1927 (b).

1.—Bisulphide of Carbon may be conveyed in tank wagons, subject to the provisions of these regulations.

2.—The Bisulphide of Carbon (Conveyance) Regulations. 1927, shall apply with the exception of Regulations 1, 2, 3, 4, 5, 12 and 14.

3.—A tank wagon used for the conveyance of bisulphide of carbon shall he constructed in accordanee with the provisions contained in the Schedule to these Regulations and together with its connections and fittings shall be maintained in good condition.

4.—The capacity of a tank wagon shall not exceed 1,000 gallons. The foregoing limitation on the capacity of a tak wagon shall be construed so as to permit of the tank containing the amount specified under varying conditions of temperature. Trailers shall not be employed with tank wagons.

5.—During the filling or emptying of a tank wagon the following precautions shall be observed :—

(i) If the wagon is mechanically driven the engine shall be stopped the whole time the filling or emptying is proceeding and shall not be run until all tanks have been securely closed.

(ii) If the wagon is horse drawn, the horses shall be removed and the wheels securely scotched before the filling or emptying is begun.

(iii) Adequate provision shall be made to prevent the accumulation of a dangerous static charge of electricity.

6.—Bisulphide of carbon in cans or packages shall not be conveyed on any tank wagon used for the conveyance of bisulphide of carbon.

7.—If electric lighting is employed on any tank wagon conveying bisulphide of carbon, the following conditions shall be complied with :—

(i) The pressure shall not exceed fourteen volts.

(ii) The circuit shall be heavily insulated from the chassis and the wiring shall be so fixed and protected as to reduce as far as possible risk of damage.

(iii) The generator, battery, switches and fuses shall be carried in front of the fire-resisting screen when fitted and the battery shall be in an easily accessible position.

(iv) Means of cutting off the current close to the battery by a double pole switch or other suitable method shall be provided.

8.—The tank of any tank wagon conveying bisulphide of carbon shall be legibly marked with the words : " Bisulphide of Carbon, Highly Inflammable."

9.—These Regulations may be referred to as the Bisulphide of Carbon (Conveyance in Tank Wagons) Regulations, 1927.

CHEMICAL SOCIETY'S LIBRARY.

The library of the Chemical Society, Burlington House, London, W.1., will be closed for stocktaking from Monday, August 1, until Saturday, August 13, inclusive, and will close each evening at 5 o'clock from August 15 to September 10.

ELEVENTH EXPOSITION OF CHEMICAL INDUSTRIES, GRAND CENTRAL PALACE, NEW YORK.

When the Eleventh Exposition of Chemical Industries opens in the Grand Central Palace for the week beginning September 26 to October 1, 1927 an educational opportunity will be offered through the Students' Course on the Fundamentals of Chemical Engineering and Industrial Chemical Practice that could not be attained any place else. The committee and Exposition management have arranged lecture courses by the leading authorities in their various subjects. These speakers are preparing to give the students of chemistry and chemical engineering a prospective of the industry as a whole. The classes will be divided into two series, the students who are advanced in chemical engineering and have had sufficient training or experience to understand how chemical equipment is made and works, and another section made up of students who have not had the opportunity or experience in unit practice or processes and their method of operation.

Registration begins Monday noon, September 26 at the Exposition and class work starts at 3 p.m., when all students will meet for a general lecture. General lectures will be given on each day for four days beginning Tuesday morning September 27 as follows :—

Arthur D. Little, "*Ethics and Ideals of the Chemical Profession.*"

H. C. Parmelee, "*What the Chemist and Engineer Reads.*"

H. E. Howe, "*What the Chemist and Engineer Writes.*"

Williams Haynes, "*How the Products Chemists make are Sold.*"

These lectures will be of a broad general scope and of value to all students. The subsequent lectures, going into the detail of unit practices for section one, will be of a more elementary nature and will illustrate and confine to the simplest possible statement the principles involved and descriptions of typical apparatus.

The plans call for two lectures a day for four days and will include consideration of the following :—

Disintegration—Crushing, grinding and pulverising.

Mechanical Separation. — Separation of solids from solids; separation of solids from liquids; separation of solids from gases; filtration, grading and classifying; centrifugal separation, settling, thickening, dust collection and precipitation; separation of liquids from liquids, etc.

Separation with Phase Changes.—Evaporation, distillation, drying and the theory and discussion of apparatus.

Handling of Materials.—Vertical, lateral, and horizontal transportation.

Materials of Construction.—What materials to use, when, where and why.

Among the speakers will be Arthur Wright, of Filtration Engineers, Inc.; S. B. Knowitz, of Raymond Bros. Impact Pulveriser Co.; W. A. McAdams, of Massachusetts Institute of Technology; A. E. Marshall of Corning Glass Works.

Among the speakers for Section Two will be: E. J. Sweetland, of United Filters Corporation, on "Mechanical Separation"; Separation of Solids from Liquids, Filtration, Continuous and Intermittent; G. Edwin White, Chemical Engineering Department, College of the City of New York, "Safety in the Laboratory and Plant"; F .A. Ernst, Fixed Nitrogen Laboratory, U. S. Department of Agriculture, "High Pressure Equipment."

In addition to these lectures it is planned to have competent guides conduct tours of inspection from exhibit to exhibit following closely upon the various lectures. Dr. T. B. Wagner will also speak on "What Technical Organisations mean to the Chemist and Engineer." The value of these courses is apparent from the number of requests from various colleges for students' admission cards for this course.

Many new and interesting developments and processes are causing much interest from students and industry from all parts of the world. Among the new exhibits and shown for the first time, is the New Aluminium Alloy invented by the late Victor E. Hybinette and perfected by his father Victor Hybinette, which is revolutionary in metal alloys inasmuch as it will be of great importance wherever nickel plated metals are used. It is non-tarnishing and can be treated to a strength very much greater than aluminium.

The United States Government exhibits will be of decided interest and importance. The management of the exposition reports that at a meeting of the Bureau Chiefs held in the office of the Secretary of Commerce, it was decided that the Department of Commerce as a whole would exhibit for the Bureau of Foreign and Domestic Commerce, Bureau of Standards, Committee on Wood Utilisation, Division of Chemicals, Division of Simplified Practice and the Machinery Division. Particulars and

details regarding these exhibits will be released later, together with particulars regarding the exhibit from the Department of Agriculture.

It is interesting to know that practically all the space on three floors of the Grand Central Palace has been sold. From such interest both domestic and foreign, it is evident that the Eleventh Exposition of Chemical Industries is attracting worldwide attention.

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL SOCIETY OF ARTS.

The 173rd Annual General Meeting for the year 1026, which was held on July 6, 1927, was a record of a year's good and useful work. On the motion of the Chairman, the Report was adopted. Votes of thanks were accorded the Secretary, and the various Officers for their services during the past year. The new Council was elected and a vote of thanks passed to the Chairman.

Among the papers read before the Society during the year were those noted below. (Abstracts of most of them have appeared in the *Chemical News*). The Chairman devoted his inaugural address to Rubber.

"The Progress of Economic Entomology" was the Trueman Wood Lecture by Dr. R. J. Tillyard, and "Artificial Silk" proved an interesting paper in the hands of Mr. Thomas Brough. "Industrial Welfare" was the theme chosen by Mr. Warre Bradley, one of the pioneers of the public welfare movement. The Rev. Père de Cleyn deputised for the Burgomaster of Antwerp with a paper on "The Port of Antwerp," which was full of facts and figures concerning this well-known Belgian seaport. "The Development of the Petroleum Industry in Persia," by Sir John Cadman, shewed how perseverance overcame many difficulties and disappointments. "British and American Practice in the Working of Hot and Cold Metals," by Mr. F. W. Spencer, shewed how improved machinery has enabled the output of manufacturers to be increased beyond the dreams of the pioneers of the metal industries. Mr. Norman Evers gave a comprehensive paper on "Chemistry and the Supply of Drugs." Dr. E. Frankland Armstrong selected for his paper "The Romance of the Organic Chemical Industry." "Some Studies in the Manufacture of Electric Lamps and Thermionic Valves" enabled Mr. C. C. Paterson to submit a paper full of interest. "Insulin and its Manufacture" proved of absorbing interest in the hands of Mr. Francis H. Carr. "The Corrosion of Metals and Joints and Crevices," by Mr. Black Evans, shewed that he had carefully studied the subject. Dr. E. W. Smith gave a paper on "The Utilisation of Gas Coke," and Mr. S. C. Orwin read one on "The Transition of Agriculture." "British Films" proved a topical paper by Sir Arthur R. Holbrook. "Fire Waste" was a paper which secured the Forthergill Trust prize of £100, by Mr. G. F. Keay. "History by Excavation," by Dr. R. E. Mortimer, shewed how interesting an apparently dry subject can be in competent hands. Mr. Arthur Robert Hyde compared Industrial Welfare in Great Britain and the United States. Several useful papers were read before the Indian and Colonial Section. The Cantor, Howard, Dr. Mann Lectures were, as usual, replete with interest.

There are various other useful movements which enter into the program of the Society, and which shew how many-sided are its activities.

NEW COUNCIL.

The Vice-Presidents retiring under the ordinary regulations are: Sir Edward Gait, Sir Robert Kindersley, Sir Philip Magnus, the Duke of Northumberland, Dr. J. Augustus Voelcker, and Sir Alfred Yarrow. In their places the Council recommend Sir Alan Garrett Anderson, Sir Alexander Gibb, Viscount Inchcape (none of whom have served on the Council in any capacity during the current year), Sir William H. Davison, Rear-Admiral James de C. Hamilton, and Professor J. M. Thomson.

The Ordinary Members of Council retiring are: Sir William Davison, Sir Archibald Denny, Rear-Admiral J. de C. Hamilton, and Professor J. M. Thomson. In their places the Council recommend the Rt. Hon. George N. Barnes, Sir William J. Pope, Col. the Master of Sempil, and Mr. J. Swinburne, none of whom have served on the Council in any capacity during the current year.

The Council also recommend the appointment of Sir Philip Magnus as a Treasurer in place of Lord Askwith, who is nominated as a Vice-President by H.R.H. the President.

WIRELESS TRANSMISSION AND THE UPPER ATMOSPHERE.

By Edward Appleton, M.A., D.Sc., Wheatstone Professor of Physics, University of London, and Fellow of St. John's College, Cambridge.

(Before the Royal Institution of Great Britain, April 29, 1227.)

It is nowadays becoming more and more evident that the atmosphere has a profound influence on the transmission of electric waves through it, and thus on wireless telegraphy generally. This influence is sometimes favourable and sometimes unfavourable to communication, and the details of some of these effects were considered.

The earliest indication of atmospheric influence was Marconi's successful transmission by spark wireless across the Atlantic in December, 1901. The distances previously negotiated by the same investigator were so short as to be explicable on the simple hypothesis that the wireless waves travelled in straight lines. But communication to America, as the late Lord Rayleigh was the first to realise, raised a new question. Could the waves bend round the protuberance of the earth as sound waves bend round a corner? Lord Rayleigh and several other mathematicians investigated the problem theoretically, and their results were unanimous in showing that some influence, other than ordinary diffractive bending, was at work. We now know that the other influence is the so-called Heaviside layer of electricity which is situated in the upper atmosphere, and which guides long wireless waves round the earth's curvature.

The more recent intensive study of wireless transmission, especially on the shorter wave-lengths, has shown that the eeffcts of the Heaviside layer can be detected only a few miles away from the transmitter. As these effects increase with increased distance, they become of importance to broadcast listeners whose receivers are 100 to 150 miles from the transmitting station. The signal fading they experience is due to the arrival of two sets of waves at the receiver, one travelling along the ground, and the other from the upper atmosphere after reflection at the Heaviside layer. Many experiments have been made in conjunction with the engineers of the B.B.C., and the National Physical Laboratory, and the height and properties of this layer have been investigated. It has been found to have a height of about 70 kilometres in the daytime. After sunset the height gradually rises, often to a height of 120 kilometres, only to fall to its day-time value on the advent of sunrise. The Heaviside layer is found to reflect broadcasting waves copiously at night, but in the day-time there is practically no reflection, and only ground waves are received. Listeners situated a long way from the transmitting station, who are only able to receive during the dark hours, often complain of the uncertain intensity and bad quality of their signals, but they should remember that the day-time signal is the one to which they are really entitled. The night-time signal they receive is merely a gift from the upper atmosphere, and they must not complain if the gift is a somewhat variable quantity.

Experiments on the very short waves have shown that the ground waves die out very rapidly, and that reception at great distances is accomplished only by means of waves deflected by the upper atmosphere.. But with decreasing wave-length the amount of bending the atmosphere can accomplish becomes less, so that with very short waves a penetration of the Heaviside layer becomes feasible, especially at night when the amount of electricity in the upper atmosphere is least. It has often been said that wireless communication with Mars is impossible, because the Heaviside layer would present an impenetrable barrier to wireless waves, but, from calculations I have made, it appears as if waves of the order of one metre would penetrate it at night, and thus be of no use for long-distance communication. Such wave-lengths would obviously be the ones to use if an attempt to communicate with another planet were seriously contemplated.

A surprising result has recently been found in the effects of magnetic storms on wireless transmission. Such storms are found to interfere very seriously with long-distance transmission, and yet with very long waves the signals are stronger than usual. It is possible to explain these queer results in terms of the Heaviside layer theory if we assume that a magnetic storm increases the electricity in the layer. In such a case the short waves, which have to penetrate the layer to be bent gradually back to the ground are more strongly absorbed, because they are returned at lower levels where the friction experienced by the electricity is larger. On the other hand, the long waves are truly reflected by the layer at its surface, and an increase in the amount of electricity in the layer increases

The trend of modern wireless development is such that the radio-engineer of the future will aim at using the beneficient influences of the upper atmosphere to the fullest extent. If we attempt to weigh up the advantages and disadvantages of the Heaviside layer, we must count the successes of long-distance transmission, which are brought about solely by atmospheric influences, as more than setting off the fading troubles experienced at various times, so that on the whole the ionised layer must be considered as a real boon to mankind.

THE FARADAY SOCIETY.

April 23, 1927.

The Significance of the Activity Coefficient. By MERLE RANDALL. (University of California, Berkeley, California.)

In the development of the theory of solutions, there have been formulated, not only the purely thermodynamic treatments, but also various mechanisms to aid us in explaining the behaviour of these interesting systems. As the formulæ derived thermodynamically often resemble, and are, therefore, often confused with, those derived from a mechanistic viewpoint, it is well to consider the limitations of the thermodynamic method.

The science of thermodynamics cannot take cognisance of the molecular mechanism of a process or of the nature and character of the various molecular species concerned. A pure substance obeys the same rigorous thermodynamic laws whether its molecules are all of one sort, as we imagine them to be in hexane or florobenzene, or diversified as we assume them to be in water. The only thermodynamic requirement is that the various molecular species be in extremely rapid equilibrium.

Bancroft has criticised the thermodynamic or activity concept because " . . . the activities are the values which one must substitute for the concentration in order to make the formulas fit," This, he continues, means " that we give up all attempts either to test or improve our formulæ." Bancroft has given a clear and correct definition of the activity as used in the purely thermodynamic formulæ, derived rigorously from the second law of thermodynamics. These formulæ are, therefore, true if we are willing to accept the validity of the second law.

Some extremists have refused to recognise the existence of atoms, molecules or electrons. In fact, if the composition of a solution is expressed by the percentages of the various substances present, the thermodynamics of the system can be readily formulated. In the case of concentrated aqueous solutions of sulphur trioxide or of phosphorus pentoxide the results obtained may be as simple as when the composition of the solution is expressed in terms of mol fractions of chosen molecular species. However, the use of mol fraction as a unit of composition, need not imply the actual existence of molecules, for the molal weight or formula weight, thermodynamically, can be looked upon as convenient unit of mass without further implications.

The activity concept is a thermodynamic device which has made it possible to bring into agreement the results of the various experimental methods of measuring the colligative properties of a solution. Having chosen to express the composition of a solution in terms of particular molecular species (without regard to the actual existence of these molecules), the activity coefficient gives us a simple empirical expression for the properties of this solution as compared with a perfect solution of the same composition. The perfect solution is one which obeys the generalised statement of Raoult's Law as defined by Lewis. (The fugacity of each constituent is proportional to the mol fraction of that constituent at every temperature and at every pressure.) Because this law is a limiting law in dilute solution (approached in dilute solutions by the laws derived from the mechanistic hypotheses), agreement with the laws of the perfect solution has become a criterion of the correct choice of a molecular mechanism a solution.

When we study a solution we make purely arbitrary choices of the chemical species of which we consider the solution composed. In aqueous solutions the solute, water, is known to consist of many kinds of molecules. The relative amounts of the different molecular species are known to change with the temperature or when a solute is added, yet in the absence of any method of determining these amounts we arbitrarily choose to consider that the solute consists of a single species, namely H_2O. Since the other species are in rapid equilibrium with this species, thermodynamics gives us consistent results, although the change of the activity of the water with temperature or composition may not follow any simple law.

So also we make arbitrary assumptions in the choice of the solute. Consciously or unconsciously we are led to choose the formulæ of the dissolved substances so that Raoult's Law is satisfied. The substances so chosen need not actually be present in appreciable amounts, their choice is extra-thermodynamic and any substances in rapid equilibrium with the constituents would serve just as well.

Bancroft's statement that the proponents of the activity concept are not interested in what happens when a neutral salt is added to an acid solution is hardly true. The change in the activity coefficient of the acid is a numerical statement of the changed conditions. But to invent a mechanism such that all the substances will follow exactly the law preferred by a particular author may involve greater empiricism than is implied in the statement that the activity coefficient has changed by a certain amount. However, if we choose a simple mechanism and the thermodynamic machine finds that the deviations from the laws of the perfect solution are small, we consider the problem solved. But, if, on the other hand, the thermodynamic machine finds the deviations large, we may either invent a more complicated mechanism, or accept the activity coefficient as the measure of the insufficiency of the simple mechanism.

For example, the ionic theory offered a mechanism which reduced the enormous deviations from the law of the "perfect solution" when a salt is dissolved in water. The inter-ionic attraction theory of Debye and Hückel still further reduces these deviations by taking into account the effect of the inner-ionic electrical forces in the mechanistic formulas. Bjerrum has offered still another mechanism to take care of deviations from the simple inter-ionic attraction theory, but always there will remain a small correction number or activity coefficient to suggest further mechanistic inventions.

On the other hand no one has heen able to invent a molecular mechanism involving the formation of complex substances which will account for the deviations observed when two liquid phases are formed.

Hydrated Solutes.—If the solute is known to be hydrated, the anhydrous species is nevertheless usually chosen. Numerous exceptions to this rule are made, however; for example, we take NH_4OH rather than NH_2, H_2SO_4 rather than SO_3, but use HCl rather than H^3ClO. If x molecules of water are assumed to be combined with each solute molecule then in a molal solution of the unhydrated solute we we would have 1 mol. of hydrated solute per 1000   18.01x grams of water, or the molality on the new basis is greater. Many efforts have been made to explain the deviations of a solution of sugar from Raoult's Law by calculating a composition of the solute which would exactly satisfy the law of the perfect solution, but these calculations usually involve different solvations at different concentrations, and are thus in a sense just as empirical as the activity coefficient itself.

Strong Electrolytes.—Since we find experimentally that the activity of a hydrogen chloride solution varies approximately as the square of the molality in the most dilute solutions, we define the standard state or condition of unit activity of the solution in such a way that the activity of the hydrogen ion and of the chloride is equal to the molality in an infinitely dilute solution, rather than in such a way that the activity of the hydrogen chloride is equal to its molality, an assumption which could be followed through thermodynamically but with rather complicated expressions.

Many authors have also assumed that the solution consists wholly of ions (complete dissociation), and Debye and Hückel have shown that if the ions are assumed to obey Raoult's Law in a classical sense, then the actually found activity coefficient may be nearly represented by taking into account the inter-ionic electrical forces.

Two important assumptions are tacitly made in the above definition of the standard state. The first is that for a reaction such as

$$HCl(aq) = H^+ + Cl^-,$$

we may write,

$$K = a(H^+) \times a(Cl^-)a(HCl) = 1 ; \Delta F^\circ = 0 \qquad \text{I.}$$

where K is the equilibrium constant and ΔF° is the increase in free energy when all the substances are in their standard states or at unit activity. In other words a suitable standard state of the undissociated hydrogen chloride is arbitrarily chosen so that the mathematical relationship implied in Equation I is always satisfied. It seems hopeless to attempt to define a standard state for the undissociated acid in terms of its molality as such, as can be done in the case of acetic acid and other weak electrolytes, where we may from the behaviour in the concentrated solution take the standard state of acetic acid in such a way that the molality of the undis-

sociated acid (corrected for the fraction dissociated) is equal to its molarity in dilute solutions. Randall and Failey have found that the activity coefficient of the undissociated part of a moderately strong acid, such as dichloroacetic acid, as well as that of weak acids, is affected by the presence of ions and, even if we were able to determine the molality of the undissociated hydrogen chloride as such, we should be forced to consider its activity coefficient in the presence of its ions.

The second assumption is that for the hydrated substances we may write :—

$$H^+ + Cl^- + xH_2O = (H \,.\, yH_2O)^+ + (Cl \,.\, zH_2O)^- ;$$
$$K = [a(H \,.\, yH_2O) \times a(Cl \,.\, zH_2O)] / [a(H^+) \times a(Cl) \times a^x(H_2O)] = 1 ; \quad \Delta F^\circ = 0$$

II.

or

$$H^+ + Cl^- + xH_2O = HCl \,.\, xH_2O;\ K = a(HCl \,.\, xH_2O)/ [a(H^+) \times a(Cl^-) \times a^x(H_2O)] = 1 ;\ \Delta F^\circ = 0$$

III.

the activity of the hydrogen and chloride ion being defined in the usual manner, and that of the hydrated ions or hydrated undissociated substances being assumed to change in such a manner that K always remains equal to unity. In order to use a separate standard state for the hydrated ions and undissociated acid, it would be necessary to know the molality of each of these substances over a range of concentration. It does not seem possible ever to obtain these data experimentally, and the assumption of Equation I is therefore justified.

Since the molality of the hydrated or of the unhydrated ion is the same at infinite dilution, the standard state of these substances is the same as that taken for the unsolvated ion. Bjerrum has qualitatively explained the abnormally high activity coefficient of the ions of hydrochloric acid by assuming hydration and taking the molality equal to the mols. of acid per 1000 g. of uncombined water.

Concentration, Molality or Mol. Fraction.—In considering aqueous solutions, it is the usual practice to express the composition as concentration in mols. per litre ar as molality in mols. per 1,000 g. of water in vacuum. Since the concentration changes with the temperature owing to the expansion of the solution, the composition in terms of mols. per litre is not a desirable thermodynamic function and should not be used. The molality is proportional to the mol. fraction in dilute solutions, but the ratio is larger in the more concentrated, and becomes infinity in the limit, or pure solute.

Since all solutions approach the laws of the perfect solution with increasing dilution, it is convenient to define the standard state, or condition of unit activity, of both the solvent and solute with reference to the dilute solution. Hence, we define the activity of a molecular species of a solute as equal to its molality in the infinitely dilute solution. Although the mol. fraction is theoretically a more desirable unit of composition, there are many advantages in using molality in the practical calculation of activity coefficients.

Obviously, even if the solution obeys Raoult's Law over the whole range, *i.e.*, perfect solution, this definition would require a decrease of the activity coefficient by nearly two per cent. in a molal solution, due to the change in the ratio of the molality to the mol. fraction. In using the activity coefficient as a criterion of the correctness of a mechanism we must take into account the effect of this chauge.

Summary.—We must recognise that thermodynamics is not concerned with the mechanism of a process. If we express the composition of a solution in terms of the molecular weights of arbitrarily chosen molecular species, then the activity coefficient gives us a simple numerical statement of the deviation of this solution from the laws of the perfect solntion. The laws based upon various mechanistic hypotheses all tend to approach the law of the perfect solution as a limit. The activity concept has enabled us to bring the various colligative properties of a solution into agreement. It offers, therefore, a test and a guide to the adequacy of the various mechanisms which may from time to time be proposed.

ROYAL SOCIETY FOR THE ENCOURAGEMENT OF ARTS, MANUFACTURES AND COMMERCE.

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COMPETITION OF INDUSTRIAL DESIGNS, 1927.

A selection of the designs received in the above Competition for Prizes and Scholarships offered by the Society and well-known manufacturers will be exhibited, by kind permission of the Board of Governors, in the Indian Pavilion of the Imperial Institute, South Kensington, from the 30 July to the 31 August next, every week-day from 10 a.m. to 5 p.m. (Sundays, 2.30 to 6 p.m.)

The Exhibition is open free of charge; no tickets are required. It will include designs in architectural decoration (wrought iron gates for a City Company, entrance hall for a block of flats, topographical drawings, etc.) textiles, furniture, printing and book-production, china, earthenware and glass, as well as designs for posters, showcards, lay-out, cartons and price lists.

A bureau of information has been established at the Royal Society of Arts in connection with the Competition, at which are kept the names and addresses of exhibitors who desire to obtain employment as designers. These lists are at the service of manufacturers in search of designers.

GEOLOGICAL SOCIETY.

The following communications were read :—

The Kateruk Series and Associated Rocks of the Northern Suk Hills (Kenya Colony). By VINCENT G. GLENDAY, M.A., F.G.S., AND JOHN PARKINSON, M.A., Sc.D., F.G.S.

The paper describes a series of completely metamorphosed sediments which crop out on or near the Kateruk River, an eastward-flowing tributary of the Turkwal River, situated about 35° 15′ long. E, and 2° 37′ lat. N., in the north-western part of Kenya Colony. The rocks consist of the metamorphosed representatives of various sedimentary deposits, ashes being included. The constiuents indicate a somewhat lower grade of metamorphism than those of the Turoka Series of the south, and it is considered that, although closely related to the latter, the Kateruk Series may eventually prove to be slightly younger. Gabbros, considerably altered, are intrusive in these rocks, and are believed to pass into certain hornblende-schists. On the other hand, some of the latter are thought to be ashes

The Occurrence, Morphology, and Affinities of the Silurian Echinoidea Echinocystis *and* Palæodiscus. By PROF. HERBERT LEADER HAWKINS, D.Sc., F.G.S., AND MISS S. M. HAMPTON, B.Sc.

Church Hill Quarry, near Leintwardine, has a reputation that seems out of proportion to its size. The flaggy mudstones (of Lower Ludlow age) have yielded a noteworthy assemblage of types not known elsewhere. This is especially true of the Echinoderma. Curious forms, such as *Palæodiscus*, are found there only; and Stelleroids of the genera *Lapworthura*, *Furcaster*, and *Sturtzaster* (together with several Crinoids) often occur in matter seams.

With support from the British Association Committee for Excavation of Sections in Palæozoic Rocks, the long-abandoned quarry was re-opened, and a careful record of the sediments was made, with intent to ascertain the conditions of their formation. A column of rock was excavated to a depth of 12 feet 6 inches from the surface. The beds traversed are all calcareous flaggy mudstones, varying slightly in lime-content. Ripple-marked surfaces were found at two horizons. Many bedding-planes are crowded with *Monograptus leintwardinensis*; others are covered with small *Leptæna rhomboidalis*; but fossils are very rare, except in such congested bands. Two "starfish" beds were cut through—the upper containing *Furcaster*, *Echinocystis*, and *Palæodiscus*, and the lower (5 feet below) made up of *Lapworthura* and Crinoids. From the combined evidence of the sediments and the distribution of the fossils, it is deduced that the series accumulated in shallow lagoon-water, and that the indigenous fauna of Echinoderms and *Lingulæ* was periodically reinforced by brachipods, pteropods, and graptolites drifted in during storms.

New material of *Echinocystis* and *Palæodiscus*, including specimens which show obverse and reverse casts, and others showing upper and under surfaces of the test, has made it possible to solve many of the problems associated with the genera. They have been placed in a special order of Echinoidea (sometimes of Cystidea) in the belief that they show affinities with Cystids (particularly Edrioasteroids) and Stelleroids as well as with Echinoids. It has been claimed that they are acyclic or exocyclic, and that their ambulacra include relics of "Asteroid" ossicles under the "Echinoid" plates. Re-examination of the original material in the light of the new specimens seems conclusively to disprove both claims.

Echinocystis is revealed as a typical Periscroechinoid, with a normal endocyclic apical system and an advanced complexity of ambulacral structure. It is very nearly allied to the Lepidocentridæ, but is provisionally kept as the type of a separate family. "*Palechinus*" *phillipsiæ* from the Valentian is believed to be an *Echinocystis*, and possibly "*Eocidaris*" *acuaria* from the Upper Devonian should be included in the genus or family.

Palæodiscus is redescribed from a large suite of new specimens which collectively show it in almost every aspect. The indications of an endocyclic apical system seem convincing. The reputed "Asteroid" ambulacral plates are shown to be knob-like ingrowths from the perradial zones of the otherwise normal plates, and their relation to the mechanics of flexibility are discussed. Similar structures occur in *Hyattechinus*, a form closely akin (morphologically) to *Palæodiscus*. This genus is referred to the Lepidocentridæ.

Both genera are claimed as advanced Perischoechinoids—far too specialised to show pre-Echinoid features. The order Echinocystoidea (with various pseudonyms) must be abandoned; and hypotheses on Echinoid phylogeny that are based on misconception of these two genera are unsubstantial.

BIOCHEMISTRY AND MEDICINE.

A large proportion of the funds available for medical research are nowadays allotted to laboratory workers whose investigations are appaprently remote from the problems of the bedside and consulting-room. This policy is justified by the history of medicine and is only dangerous when allowed to bring clinical work into disrepute. If to-day the trend of ancillary research is largely towards biochemistry tha is because this science offers the largest uncultivated area to the pioneer. The horizons are illimitable and the land is rich; all that is necessary is its exploitation. For centuries there have been extending settlements around the coast from which the old world of medicine has drawn new life, but until recently only a few individuals have devoted their lives to exploring the hinterland. Now at last these isolated journeys are being correlated and the country between them begins to appear upon our maps. Fortunately, there are more and more benefactors ready to finance the survey and development of this new territory in the interests of medicine, and an example of their wisdom is the Institute of Biochemistry opened recently at the Middlesex Hospital. This admirable department will be directed by Prof. E. C. Dodds, who has himself brought back much that is valuable from his expeditions into unknown and difficult country As he pointed out at the opening ceremony, it is apparent that biochemistry "has already given us great and generally admitted benefits which are a tremendous encouragement to the pursuit of the study." The victories of the pioneers, he said, have already passed into the routine of medical practice; but while so much remains unknown the investigators—however many—are still pioneers. The new Institnte will be an admirable starting-point for fresh endeavour.—*The Lancet*.

NOTICES OF BOOKS.

The Structure of the Atom. By E. N. DA C. ANDRADE. Pp. XVIII + 750. Third edition revised and enlarged. Bell & Sons, Ltd., Portugal Street, London, W.C.2. 30s.

Since the first edition of this book appeared considerable advances have been made in the extensive field of atomic physics, so that the present volume will be welcome as containing much new material. The sections on the passage of swift corpuscles through atoms and the disruption of the nucleus by alpha particles are to-day of particular interest and the treatment leaves nothing to be desired in this respect. Mention is made of the recent work of Kirsch and Pettersson wherein their results possibly extend those of Rutherford. The *Zeitschrift für Physik*, 1927 XLII, page 641 to 759, contains further work of a confirmatory nature by Kirsch, Pettersson, Holoubek and Stetter, being a series of papers covering the various phases of this field of research. So far as can be judged at present oxygen and helium seem to resist change in this respect. Oxygen is highly magnetic compared with all other elements below the iron group. There is no discussion from this point of view, but on page 583 the specific susceptibilities of the elements plotted against atomic number are given, as in the first edition, so that the reader has ample material condensed in one volume to study with great profit. In this section the section on magnetic properties is fairly complete and the work of Gerlach and Stern is beautifully illustrated.

Since this book went to press work in America has added to the important findings of these investigators.

The magnetic phase of atomic physics is, however, not in a satisfactory state, as there seems to be something yet to be discovered which will enable the complex phenomena of magnetism to be reduced to a comprehensive basic treatment. In order to be convinced beyond doubt that a certain theory is in main the true theory, the trouble of chance coincidences must be eliminated, yet this becomes more and more difficult as there are so many variable factors and so many atomic types and molecular complexes, that coincident relations which look fortuitious are perhaps not of this category at all.

In view of the great work going on in all educational centres which is becoming more and more optical, more space might have been given to fine-line structure especially the details of the brilliant work of Sommerfeld and Paschen. This is of course, summarised, and Plate V opposite page 239, shows the famous singly ionised helium lines—*i.e.*, the fine structure of lines 4686 and 3203.

The section dealing with periodic properties of the elements from the standpoint of atomic optics will be of interest to the chemist, and on page 473 a most interesting periodic table is given, except that in such " perfect " tables the rare-earth elements have to be squeezed together and fitted into one place, though they are not isotopes and have distinct atomic numbers. This is, obviously, realised and the author is quite justified in giving several modifications of the periodic scheme, including Bohr's table which obviates this difficulty.

It is not clear that 92 is the last element of the series as if elements can exist in such minute quantities as those supposed to be recently discovered, 43, 61, and 75, then 93 might exist and if strongly magnetic perhaps its atomic structure is much more stable than those immediately below it in atomic number. See remark above *re* oxygen. Some evidence of the existence of 93 has been published in these pages, but work of this kind unless followed up and confirmed cannot be accepted. Andrade does not, of course, limit the number of elements to 92, and as far as can be seen, takes a wide and sympathetic view on the matter.

The treatment of the static model of the atom is fairly complete considering that the material must be cut down to get the book into reasonable limits.

The section on multiplet structure and the anomalous Zeeman effect will be read with interest.

The newer wave mechanics involving or embracing the theory of matrices as applied to the atom is not treated, as this is of recent development. The work of Schrödinger and others sets aside the present dynamic theory that the electrons actually describe orbits as the planets do, substituting in its place a wave mechanics. Andrade, on page 712, says : " The new quantum theory is still on its trial, but it has started off with considerable achievements just as did the old. The difficulties of the half integral quantum numbers do not occur with it; the theory decides of itself, and rightly, whether a quantum number is to be integral or half integral. The dispersion theory of Kramers falls naturally within its scope, as even the little that has been said here would indicate. Pauli has succeeded in deducing the formula for the Balmer series, the Stark effect, and the fine structure from the new theory. As regards the anomalous Zeeman effect and multiplet structure ,nothing can be done so long as the electron is considered as having only three degrees of fredom. If, however, the spinning electron of Uhlenbeck and Goudsmit be introduced, possessing itself mechanical and magnetic moment, the ratio of which is double as great as it is for the atom itself, then the new mechanics can give an account of the features just cited. Much may be hoped from the combination of spinning electron and new mechanics, but so far as the spectrum of neutral helium awaits calculation. Still more recently Schrödinger has put forward a theory of atomic mechanics which is based on ideas of L. de Broglie's concerning the theory of groups of waves" Recent work in America further supports this new theory.

On page 197 Andrade says : " Fowler's determinations give for R_{He} /F_H the numerical value 1.0004095, which gives for the ratio m/M the value 1/1831—Paschen, as a result of further investigation of the spectroscopic constants, finds by this method M/m = 1847. His value for R_{He} is 109722.14 *plus* or *minus* 0.04, which is, of course, derived from laboratory measurements. H. H. Plaskett's value, derived from astrophysical measurements, is 109722.8 *plus* or *minus* 0.44, agreeing within estimated experimental error—[this appears in a footnote]. This value, calculated by applying the quantum theory of spectroscopic data, agrees closely with the

accepted value, deduced from very different experimental evidence. *In the face of this agreement is is hard to deny that the conception of the revolving electron must correspond closely to reality (as understood by the physicist), at any rate as far as the hydrogen-like atom is concerned.*" The italics are the present writer's.

On page 708 Andrade remarks: "The quantum theory has become, in its higher branches, a collection of numerical receipts, to which a superficial resemblance to a coherent mathematical theory has been given to hide their *ad hoc* character. The difficulty of understanding them is not mathematical, but fundamental. Some of the rules recall irresistibly the teaching of the alchemists, or the witches' kitchen in *Faust*." This may be a healthy dose of medicine to take, but it is hard to keep a smooth face when swallowing it.

This book in get up and printing, does great credit to the well-known publishers.

F. H. L.

Old Chemistries. By EDGAR F. SMITH. Pp. 90. New York: McGraw Hill Book Co. 1927.

Scientists in general and American scientists in particular, owe their thanks to Prof. Edgar Smith for his efforts to stimulate an interest in the history of chemistry. Readers of this Journal will recall a number of Prof. Smith's essays and biographies. In the present volume he surveys a number of interesting old texts and treatises which had a vogue and influenced the development and dissemination of chemical knowledge in their time.

The book begins with some Latin texts of Geber, *i.e.*, Jabir ibn Hayyan. He goes on to quote and describe Tomas Williams 'Art of Distillation" (London, 1653) and reproduces some of the plates.

Further examples of early chemical books are Themaut's "Cours de Chimic" (Paris, 1667) and N. L. du Fresnoy's "Histoire de la Philosophie Hermetique" (Paris, 1742). But Prof. Smith's real object is to direct attention to early American texts or translations. He is convinced that the American 'Fathers of Chemistry' had as keen an interest in their science as have their modern disciples.

The first chair of Chemistry was established in the University of Pennsylvania in 1769 and was filled by Benjamin Rush who had received his instruction from Joseph Black in Edinburgh. His *Syllabus* was the first textual contribution in chemistry from an American.

Heron's translation (dedicated to Black) of Fourcroy's *Elements of Chemistry*, 1796, had a considerable influence in America, especially as reference was made to Lavoisier's new system of nomenclature and also to incidents in the lives of those participating in the evolution of modern chemistry.

The works of Bergmann, Macquier, Orfila, John Murray, Wm. Henry, James Cutbush, Thomas Ewell, Samuel Parkes, Frederick Accum, Thomas Thomson, Jane Marcet, J. F. Dana, the Sillimans, Robert Hare, Joseph Black and others are passed in charming review. There are many fine reproductions and the book is printed on paper which gives it a venerable tone. It is to be hoped that Prof. Smith's latest volume will be widely read and will stimulate chemists to take a greater interest in the early development of their science.

J. G. F. DRUCE.

New Patents.

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Latest Patent Applications.

18,045.—Goley, H. E.—Manufacture of barium sulphide, etc. July 7th.

17,709.—Fodor, A.—Preparing acid of phtalic series, etc. July 4th.

17,786.—Ewan, T.—Manufacture of carbon from barbon monoxide. July 5th.

18,199.—I. G. Farbenindustrie Akt.-Ges. —*Manufacture of sulphamic acids* of secondary bases. July 8th.

18,184.—I. G. Farbenindustrie Akt.-Ges. Manufacture of napththalene-1.4.8.-tetracarboxylic acid. July 8th.

Specifications Published.

269,118.—Allgemeine Ges. fur Chemische industrie.—Method of and expelling the S02 gases from mixtures of S02 gases and oil.

Abstracts Published

271,254.—Fermentation processess.—Langwell, H., The Garth, Windmill End, Epsom, Surrey, Ricard, E., Melle, Deux-Sevres, France, and Burton, W. A., Aldwych House, *Aldwych, London.*

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CONSTITUTIONS OF THE HYDROBORONS.

By J. D. MAIN SMITH, Ph.D., B.Sc.

One of the most obscure problems in chemistry to-day is the constitution of the hydrides of boron, referred to as hydroborons from analogy with hydrocarbons. For the preparation of the hydroborons and their derivatives, which bid fair to rival organic compounds in complexity if not in number, chemical science is indebted to the indefatigable work of Professor Stock and his collaborators. The simplest hydroboron, that appears capable of existence, contains two atoms of boron, and is analogous in formula and many chemical and physical properties to ethane. Theoretically the simplest hydroboron should be boron trihydride, BH_3, but all endeavours to attain this compound have resulted in the isolation of the dimeric compound diborane, B_2H_6.

Within the last few years, numerous attempts have been made to assign a rational constitution to the hydroborons, but so far without success. So persistent have been the failures to assign even a plausible constitution to the simplest hydroboron, that these compounds must be regarded as a decisive test of any theory of valency. Professor G. T. Morgan some time ago put the matter in an epigram, " The theories of integral valency were founded on the hydrocarbons. They will founder on the hydroborons."

It is worthy of remark that nearly all attempts to assign constitutions to the hydroborons have had an electronic basis, Langmuir's theory of the invariable covalency bond of two electrons being utilised. I have frequently called attention to the inadequacy of the conception of an invariable di-electronic bond (*J.S.C.I.*, 1923, XLII, 1075; 1924, XLIII, 323; 1925, XLIV, 944; *Trans. Faraday Soc.*, 1925, XXI, 355; and " Chemistry and Atomic Structure," 1924, 123 and 179), and have emphasised that a chemical bond frequently consists of a single electron, a view put forward in 1921 by Thomson. The conception of a bond of a single electron has been successfully used by a number of workers on electronic valency, and is now utilised in the elucidation of the constitutions of all the known hydroborons.

It is unnecessary here to enter into details of the various experimental facts which suggest when a chemical bond is of one electron or of two electrons. It will be sufficient for the hydroborons to deal with hydrogen. The di-electronic bond or covalency originated with the analogy between the structures of methane and neon, each having eight outer electrons. The cardinal chemical fact about the four hydrogen atoms of methane is their replaceability atom for atom by the halogen elements. If the hydrogen atoms of methane are each bound by a bond of two electrons, their replaceability by halogen atoms involves that the halogen atoms are also bound by a bond of two electrons. We thus have the guiding principle that if a hydrogen atom is directly replaceable by a halogen atom, it is bound by a di-electronic bond, and, inferentially, that if a hydrogen atom is not so replaceable it is bound by a bond of a single electron. We may exclude from consideration cases of hydrogen atoms which are ions or potential ions replaceable by alkali atoms but not replaceable by

halogen atoms, as the hydrogen atoms of the hydroborons are not directly replaceable by alkali metals.

A single example will illustrate the application of the rule to the hydroborons. Pentaborane, B_5H_9, forms a compound with four molecules of ammonia, $B_5H_9(NH_3)_4$. This ammine contains four hydrogen atoms readily replaceable by chlorine atoms, yielding the tetrachloro-ammine, $B_5H_5Cl_4(NH_3)_4$ indicating that four hydrogen atoms are bound by di-electronic bonds. Further hydrogen atoms can be directly replaced by chlorine atoms, but with increasing difficulty, forming successively the pentachloro-ammine, $B_5H_4Cl_5(NH_3)_4$, the hexachloro-ammine, $B_5H_3Cl_6(NH_3)_4$, and the heptachloro-ammine, $B_5H_2Cl_7(NH_3)_4$. The chlorination comes to an end when seven of the nine hydrogen atoms of pentaborane have been replaced by chlorine, indicating that seven hydrogen atoms are bound by di-electronic bonds and two hydrogen atoms by mono-electronic bonds. This accounts for 16 of the 24 electrons in the compound, leaving only 8 electrons for the four bonds necessary to hold five boron atoms together. If the borane is a straight-chain compound, as its low boiling point and general properties indicate, only two boron atoms can be terminal atoms, and the boron part of the molecule is thus analogous to normal pentane, each bond between boron atoms being of two electrons.

Further, allowing a hydrogen atom with a di-electronic bond to each of the five boron atoms, each of the three median boron atoms carries only six electrons. Addition of a molecule of ammonia to each of these median boron atoms involves an addition of two electrons per atom, thus completing octets of electrons on three boron atoms. The borane, however, forms a tetrammine not a pentammine, indicating that only one of the terminal boron atoms possesses six electrons completed to an octet by addition of two from the fourth ammonia molecule. The remaining boron atom, consequently possesses a complete octet of electrons and thus cannot add electrons from a fifth ammonia molecule. Two of the eight electrons being bound to the next boron atom involves that six electrons are left to bind three hydrogen atoms by means of three di-electronic bonds. One end of the borane chain is thus a boranyl group, BH_3, containing three replaceable hydrogen atoms and completely analogous to a methyl group. The other terminal boron atom possesses only six electrons, of which two are bound to the next boron atom, leaving only four electrons to bind the remaining three hydrogen atoms. This involves that this end of the borane chain is a boranyl group, BH_3, which is *not* analogous to a methyl group, two of the hydrogen atoms being bound in mono-electronic bonds and therefore not replaceable by halogen atoms. One of the characteristics of the methyl group in organic chemistry is its comparative inertness to substitution by chlorine for hydrogen, summarised in the well-known reference, "the persistence of the methyl group." The terminal boranyl group analogous to the methyl group may thus be regarded as the group which is with difficulty attacked by chlorine, the first product of chlorination thus being a tetrachloro-derivative and the final product a hepta-chloro-derivative. The constitution of pentaborane is thus deduced to be

$$(H:)_3B:\underset{\underset{H}{\cdot\cdot}}{B}:\underset{\underset{H}{\cdot\cdot}}{B}:\underset{\underset{H}{\cdot\cdot}}{B}:\underset{\underset{H}{\cdot\cdot}}{B}(\cdot H)_2,$$

where each dot represents an electron.

The postulate of one electron per bond for hydrogen atoms not replaceable by halogen atoms is, however, not in itself sufficient to determine the boron atoms to which such hydrogen atoms are attached, nor is the fact, that three hydrogen atoms in pentaborane are replaceable with increasing difficulty by chlorine atoms, conclusive evidence that these three hydrogen atoms are all attached to the same terminal boron atom to form a boranyl group analogous to the methyl group. For the elucidation of these finer points of constitution, it is necessary to have regard to more intimate details of the distribution of electrons in atoms.

In my scheme of atomic structure (*J.S.C.I.*, 1924, XLIII, 323), each inert gas has an outer main group of 8 electrons divided into three subgroups of 2, 2 and 4 electrons. This distribution of the octet electrons was based on the chemical evidence of the periodic classification, valency and co-ordination number, and on the physical evidence of X-ray absorption bands, and has been fully confirmed by Stoner's work on the multiplet structure of spectra (*Phil. Mag.*, 1924, XLVIII, 719). The first subgroup of 2 equivalent electrons is most firmly bound, the second subgroup also of 2 equivalent electrons is less firmly bound, while the third subgroup of 4 equivalent electrons is least firmly bound.

Elements preceding each inert gas have partially completed subgroups, boron, for example, having a complete first subgroup of 2 electrons most firmly bound and an incomplete second subgroup of one electron less firmly bound. This partially completed subgrouping of 2,2,4 electrons is characteristic of all elements other than those in the transition series of the periodic classification.

It is generally conceded that all atoms other than the noble gases tend to acquire or lose electrons in chemical reactions so as to attain the structure of the next heavier or next lighter noble gas. This is commonly referred to as the " rule of eight." This is, however, a misnomer for hydrogen can gain only one electron in acquiring the structure of helium with two electrons. The rule should be referred to as " the " noble gas rule," hydrogen and helium thus being included. As the octet structure is not characteristic of the transition elements which have incomplete subgroups at lower levels than the noble gas octet, the " noble gas rule " is applicable only to elements other than the transition elements, which extend from scandium to zinc, from yttrium to cadmium, from lanthanum to mercury, and from actinium to uranium. Hydrogen, boron, nitrogen, oxygen, and the halogens, however, are not transition elements, and consequently the " noble gas rule " is applicable to the whole of the known hydroborons and their derivatives.

According to the rule, hydrogen tends to gain only one electron, boron to gain five, nitrogen three, oxygen two electrons, and the halogens one electron in order to atttain the structure of the next higher noble gas. The acquirement of electrons, however, tends to set up equal and opposite electrostatic charges on the atoms reacting, and the charges tend to draw the atoms closer and thus to cancel out the charges by juxtaposition. The obliteration of the charges is effected by each reacting atom sharing an electron of the other. This bond of two shared electrons, the so-called covalency bond, is electrostatically equivalent to one electron per atom, but nevertheless structurally equivalent to two electrons per atom.

Boron possesses three electrons and its compounds are electrostatically neutral when three electrons have been added from other atoms in three di-electronic bonds. In such combinations, boron exerts ordinary valency of three and contra-valency of three. If a boron atom acquires five electrons, thus completing an octet, it exerts ordinary valency of three and contra-valency of five. An octet of electrons may be formed by four di-electronic bonds or by three di-electronic bonds and two mono-electronic bonds. In the first case, the boron atom has a co-ordination number of 4, and in the second case a co-ordination number of 5, for four atoms are associated with boron in one case and five in the other. A co-ordination number of 4 may, however, be attained without the formation of an octet of electrons when four atoms are associated with a boron atom by two di-electronic bonds and two mono-electronic bonds. All of these possibilities are found to be realised in the hydroborons. In pentaborane, for example, the median boron atoms have a co-ordination number of 3 with six electrons, one terminal boron atom has a co-ordination number of 4 with six electrons, while the other terminal boron atom has a co-ordination number of 4 with an octet of electrons. In the tetrammine derivative, four boron atoms have a co-ordination number of 4, while the fifth boron atom has a co-ordination number of 5, thought all have octets of electrons.

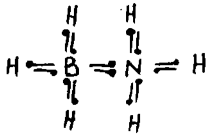
It has been indicated that in each subgroup the electrons are equivalent to one another but not equivalent to the electrons in other subgroups. It follows, in consequence, that electrons constituting mono-electronic bonds must appear in pairs at the same atom. In the electronic formulation of the hydroborons, if a hydrogen atom is bound to a boron atom by a mono-electrouie bond, it necessarily follows that a second hydrogen atom is similarly attached to the same boron atom. Considerations of atomic volume indicate that the available space round an atom is less at a median than a terminal atom, and in consequence co-ordination numbers of 5 should be found usually only at terminal atoms. In the formation of ammines in which the co-ordination number of some atom rises from 4 to 5, the large volume of the ammino-group involves that the higher co-ordination number of 5 will be found at a terminal atom.

In the case of dihydro-pentaborane, there are four hydrogen atoms bound to boron by mono-electronic bonds. In the formation of the tetrammine, two hydrogen atoms are ejected, indicating that a median boron atom carries two of the four hydrogen atoms bound by mono-electronic bonds, and that a co-ordination number of 5 cannot exist at a median boron atom when

three of the atoms attached are comparatively large atoms such as two boron atoms and one nitrogen atom. As no hydrogen is evolved in the formation of ammines of other hydroborons, it follows that a pair of hydrogen atoms bound by mono-electronic bonds cannot be present at a median boron atom, and that a terminal boron atom can have a co-ordination number of 5 on condition that three atoms of the number are the comparatively small hydrogen atoms.

A complete list is given hereunder of all the known hydroborons and their derivatives, together with the electronic structures as deduced from the experimental evidence by means of the foregoing principles. In formulating the electronic constitutions, a shared electron is represented by a dash between atoms and unshared electrons by separate dots round the atom. In order to facilitate the analysis of such formulations, each electron-dash is terminated by a dot at the end nearest the atom to which it is proper in the free atom. By this device, the maximum possible valency of an atom is the total number of dots round it; the valency actually in operation is the number of dots that terminate dashes; while the contra-valency actually operative is the number of dashes that are not dotted at the atom end.

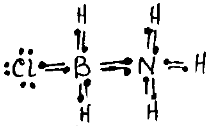
Borane Ammine, BH_3,NH_3.



(I)

Stock regards this ammine as having the dimeric formula, $B_2H_6(NH_3)_2$, on the ground that it is formed on treating diborane with ammonia. The electronic formulation of diborane, however, indicates that a double bond of four electrons exists between the boron atoms, and addition of four electrons from two ammonia molecules must sever all union between the boron atoms. The product is thus the ammine of the unknown boron trihydride, BH_3, and analogous to the ammine of boron trimethyl, $B(CH_3)_3,NH_3$.

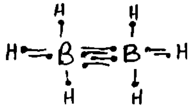
Chloro-Borane Ammine, BH_2Cl,NH_3



(II)

As in the case of the parent ammine, Stock regards this chloroammine as having the dimeric formula. If, however, it is as suggested a derivative of chloro-boron dihydride, it may be predicted that exhaustive chlorination of the ammine will yield, not hexachloro-diborane diammine, $B_2Cl_6(NH_3)_2$, but the well-known compound boron trichloride ammine, BCl_3,NH_3.

Diborane, B_2H_6.

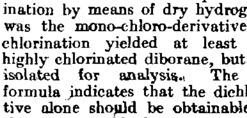


(III)

As each boron atom in this formulation has a completed octet of electrons, addition of ammonia can only take place by rupture of the inter-boron bond, yielding two molecules of mono-borane ammine (see above.)

$$B_2H_6 + 2NH_3 = 2BH_3NH_3$$

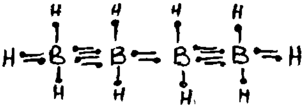
Chloro-Diborane, B_2H_5Cl.



(I

The formulation of diborane indicates that only two of the six hydrogen atoms should be replaceable by halogen atoms. Stock found that the first product of chlorination by means of dry hydrogen chloride was the mono-chloro-derivative. Further chlorination yielded at least one more highly chlorinated diborane, but it was not isolated for analysis. The electronic formula indicates that the dichloro-derivative alone should be obtainable, $B_2H_4Cl_2$, the other four hydrogen atoms being irreplaceable owing to binding in mono-electronic bonds.

TETRABORANE, B_4H_{10}.



(V)

The formula for this hydroboron follows from its ready synthesis from or iodo-diborane and sodium amalgam.

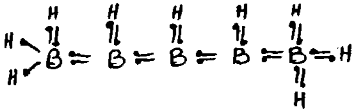
$B_2H_5I + 2Na = BH_2BH_2BH_2BH_3 + 2NaI$

As tetraborane contains two bonds of four electrons each, addition of ammonia should rupture these bonds, yielding two molecules of mono-borane ammine and one molecule of dehydro-diborane diammine.

$B_4H_{10} + 4NH_3 = 2BH_3NH_3 + B_2H_4(NH_3)_2$

This reaction has not yet been elucidated by Stock. The hydroboron, dehydro-diborane, B_2H_4, should be an analogue of ethylene, C_2H_4. As tetraborane contains only two hydrogen atoms bound by di-electronic bonds, treatment with hydrogen chloride should yield successively chloro-tetraborane, B_4H_9Cl, and dichloro-tetraborane, $B_4H_8Cl_2$. This reaction has not yet been elucidated by Stock.

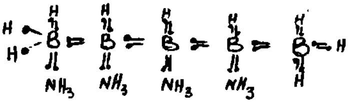
PENTABORANE, B_5H_9.



(VI)

PENTABORANE TETRAMMINE, $B_5H_9(NH_3)_4$

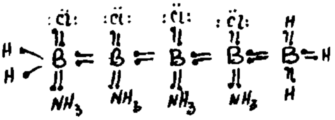
$B_5H_9 + 4NH_3 = B_5H_9(NH_3)_4$.



VII

TETRACHLORO-PENTABORANE TETRAMMINE, $B_5H_5Cl_4(NH_3)_4$

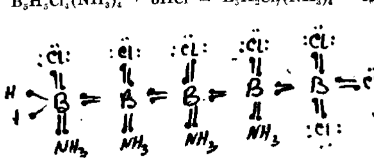
$B_5H_9(NH_3)_4 + 4HCl = B_5H_5Cl_4(NH_3)_4 + 4H_2$



VIII

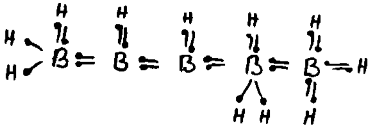
HEPTACHLORO-PENTABORANE TETRAMMINE, $B_5H_2Cl_7(NH_3)_4$

$B_5H_5Cl_4(NH_3)_4 + 3HCl = B_5H_2Cl_7(NH_3)_4 + 3H_2$



IX

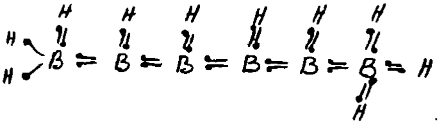
Dihydro-Pentaborane, B_5H_{11}



(X)

On treatment with ammonia, this hydroboron loses two atoms of hydrogen and forms a tetrammine. According to the foregoing electronic structure, the two hydrogen atoms replaced by a molecule of ammonia should be those attached by monoelectronic bonds to a median boron atom, the resultant tetrammine being identical with that from pentaborane. Stock records that the tetrammines from the two pentaboranes are very similar but does not claim that they are identical. He states, however, that the terammine from B_5H_{11} can be chlorinated to yield a tetrachloro-derivative closely resembling the tetrachloro-derivative from the tetrammine of B_5H_9.

Hexaborane, B_6H_{10}.



(XI)

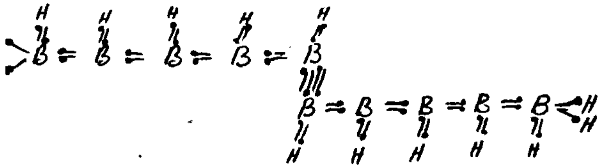
This hydroboron, having only one boron atom with an octet of electrons, should yield a pentammine, and the latter should be chlorinateable to yield penta-, hexa-, hepta-, and octa-chloro-derivatives, as the formula indicates that it contains from five to eight atoms of hydrogen bound by di-electronic bonds.

Dekaborane, $B_{10}H_{14}$.

the spontaneous decomposition of dihydro-pentaborane.

$$2B_5H_{11} = B_{10}H_{14} + 4H_2$$

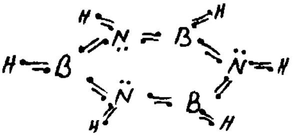
This hydroboron is a common decomposition product of simpler hydroborons, and it is readily formed synthetically in



(XII)

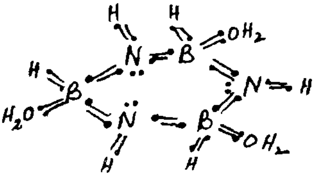
Owing to the presence of the tetra-electronic bond, this borane should be readily halogenated at the two median boron atoms, yielding boron halide and derivatives of tetraborane.

CYCLO-TRI-IMIDOBORANE, $(BHNH)_3$.



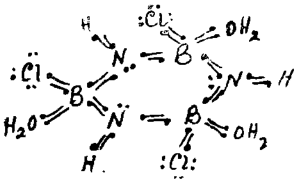
(XIII)

This formulation indicates that the compound is the polymeric form of monoborane imide, BH : NH, and analogous in structure to triformaldehyde and cyanuric acid. As each of the three boron atoms possesses only six electrons, it should react with three molecules of ammonia or water to form a triammine or trihydrate. Stock has not succeeded in elucidating the nature of the ammonia addition product, but he found that the addition compound with water is definitely a trihydrate.



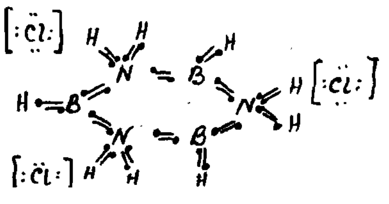
(XIV)

This trihydrate, like the anhydrous compound, possesses three hydrogen atoms attached to boron atoms by di-electronic bonds, and these hydrogen atoms should be replaceable by halogen atoms. Stock has succeeded in isolating the trichloro-derivative of the trihydrate, $(H_2O,BCl:NH)_3$.



(XV)

The anhydrous imido-borane possesses three nitrogen atoms each having two unshared electrons available for addition to a hydrogen atom in ammonium formation, and should form an addition compound with three molecules of a mono-basic acid. Stock has in fact isolated the trihydrochloride, $(BH:NH_2Cl)_3$.



(XVI)

As the foregoing constitutions for the hydroborons were wholly based on the experimental evidence of Professor Stock and his collaborators, a copy of the paper was sent to him on 2 Feb. 1927, with a request for his views before publication. Before a reply had been received, Dr. Sugden communicated a paper on "Evidence for the Existence of Singlet Linkages in the Pentachlorides of Phosphorus and Antimony" (*J.C.S.*, 1927, 1173), in which he suggested a formula for diborane identical with that given above (III). Professor Stock's reply was not received till a week after Dr. Sugden's paper had been received by the Chemical Society. There can be no question of Dr. Sugden's priority in publication, but the circumstances indicate that my conclusions were reached quite independently. The relevant portion of Professor Stock's reply is appended:—

"I must leave the examination of your views on electron arrangement to the physicists and do not propose for the time being to enter into discussion of boron hydride. Our immediate programme is to obtain further experimental evidence, but unfortunately my removal here from Berlin necessitated the suspension of this work for six months."

"In general, with the single exception of B_5H_{11}, you arrive at the same atomic structure as I have recently published, I would further comment on your thesis in detail as follows:—

Theoretically, one should expect the boron hydride BH_5. As a necessary condition for BH_3 is that the hydrogen should be the electronegative component, much as in LiH. In your theoretical assumptions, you lay especial value on the fact that $B_2H_6(NH_3)_4$ should be chlorinated in stages and not require more than seven atoms of chlorine. Our experiments in this respect were more of a subsidiary nature. I would ask you not to take it for granted that a further chlorination is impossible. At any rate it appears to me that it does not justify broad conclusions as to structure. You have not noticed that our formula $B_2H_6(NH_3)_2$ is based on an exact determination of molecular weight."

STOCK,
Director, Karlsruhe Technical High School Chemical Institute. 10 March, 1927.

It will be observed that Professor Stock claims that his determination of the molecular weight of B_2H_6 in liquid ammonia proves that diborane ammine has the dimeric formula (*Ber.*, 1925, LVIII, 657). He himself, however, has proved that diborane combines with ammonia in the proportion of one molecule of ammonia per atom of boron. His determination of molecular weight in liquid ammonia is consequently not a determination of the molecular weight of diborane but of its ammine. If, as he claims, the ammine has the dimeric formula preserved, the molecular weight should be that of $B_2H_6(NH_3)_2$, which is 62 not 28. As the molecular weight actually found by extrapolation to zero concentration is 28, this is conclusive proof that the product obtained by dissolving diborane in ammonia, with which it reacts by addition of an ammonia molecule per boron atom, cannot contain more than one atom of boron. This confirms fully my contention that diborane diammine has no existence, and that the body isolated is mono-borane ammine, BH_3,NH_3 (I), which has a molecular weight close to that of diborane itself. I have recalculated Professor Stock's results for molecular weight, deducting from the solvent ammonia the amount required for combination, and replotted his graph. The extrapolation to zero concentration shows decisively that the molecular weight of the substance in solution lies between 27 and 35. The molecular weight of mono-borane ammine should be 31.

University Chemistry Department,
Edgbaston, Birmingham.

1 July, 1927.

JOSEPH FOSTER AND SONS (PRESTON AND LONDON.)

This well-known firm of general founders and chemical plant manufacturers has been established close upon a century. At their Soho Foundry, Preston are turned out stationery steam engines of the uniflow and other types for mill driving, pumping and other purposes; various types of boilers, plant for chemical, rubber, gunpowder, and other industries. The firm has a high reputation also for the production of printing machinery of all kinds. We have before us their handsome allustrated catalogue which gives illustrations of, among other apparati, timber impregnating plant, revolving sulphite vessel, chemical decomposer, mild steel liquor blending tank, autoclave (horizontal and vertical), benzole agitating tanks, etc.

THE ASSOCIATION OF BRITISH CHEMICAL MANUFACTURERS.

Eleventh Annual Meeting.

The Eleventh Annual General Meeting of the Association of British Chemical Manufacturers was held at the Chemical Society's Rooms, Burlington House, Piccadilly, W.1., on Thursday, July 14, 1927, for the purpose of receiving and considering the Report of the Council; electing Auditors and receiving the Report of the Scrutineers. Mr. C. A. Hill presided.

The Chairman, in moving that the Report of the Council of the Association be adopted, said :—" If I had to select one feature more prominent than any other in the Report, I should choose those paragraphs relating to International relations, not only because they introduce a new development but because of what I conceive to be their importance. There can be no doubt that looked at in one way the World is growing small; communications between Nationals are physically much easier of accomplishment; there is a general desire among peoples of different nations to meet in conference; and international arrangements are being regarded as essential to the revival of a World Trade. Hence the Report records the important development which has taken place in the formation of Imperial Chemical Industries, Ltd. This great amalgamation now represents about one-third of the capital of the firms who are members of our Association. From the international aspect, there are undoubted advantages to the British Chemical Industry of this country in having a firm of the size and importance of Imperial Chemical Industries, Ltd.

Again, during the past year the Association has joined the British National Committee of the International Chamber of Commerce which has just held a Conference in Stockholm. We have been invited to do so on previous occasions, but have not hitherto accepted the invitation. Now, however, International relations have become so important that your Council felt able to accede to the request of the National Committee.

Next I must refer to the conferences which have taken place between representativs of the Federation of British Industries and representatives of the corresponding organisations in France, Germany and Italy. As a constituent of the Federation, and with Sir Max Muspratt as President of the Federation, it was inevitable that Chemical Industry should play its part in these conferences. The burden of the work of representing Chemical Industry has fallen on Sir Max Muspratt with such help as the General Manager could render. At the Conference in Berlin last week, in the absence of Sir Max Muspratt, Sir John Brunner, and the General Manager represented the Association. All the conferences to which I have referred were bound up with the League of Nations Economic Conference at Geneva, where again Sir Max Muspratt was one of the British delegates. The paragraph in the Report says all I want to say with regard to Geneva. We certainly can say that British Chemical Industry has through your Association efficiently played its part. Our thanks are due to Sir Max Muspratt and his colleagues and our General Manager for the splendid manner in which they represented this country through a long and arduous Conference with the brilliant results which attended their efforts. (Hear, hear.) The presence of our General Manager during the last week serves to raise the question, destined to become acute if these conferences persist, as they threaten to do, as to whether private members of our Council, who are Directors of Companies, can continue to give the time, work and money, requisite to represent this country and our interests, and whether, on the other hand, these conferences will not, in the future, be attended chiefly by professional delegates, a corps of professional diplomatists. In the former case we have the knowledge of the expert and the ability of the business man, together with the enthusiasm of the amateur; in the latter case we may have equal knowledge, equal ability and—in time—greater experience, but we have to contemplate the possibility of the activities of such conferences becoming more stereotyped. On the other hand, against this possible drawback must be set the advantage of continuity of policy. If they do continue we shall be bound to take part in them in order that this country is not without a voice in the discussion of proposals, some of which would be positively harmful to us. Moreover, from some points of view we gain a good deal of advantage in being kept abreast with the trend of thought of chemical industrialists in other countries. In this connecion I desire only to refer to the proposed new French Customs Tariff. In accordance with our usual practice we have studied this very carefully. It is perhaps unfortunate that at a time when all Nations are considering the possibility of lowering their tariff walls these new proposals should have been made. Be that as it may, they have been made and must be

carefully studied. In the result we have made certain proposals to the Board of Trade for the revision of the duties which it is suggested should be increased on certain chemicals, and we await the result of the representations which our Government have no doubt made to the French Government.

I now turn to the domestic legislation, threatened and accomplished, with which we have had to deal. First, as to the threatened (and I use the word advisedly) legislation. The proposed Factories (No. 2) Bill has been dropped, for a time at least. Had it been carried to the stage of becoming an Act of Parliament it would have cost Chemical Industry, in common with the other great industries of the country, a very considerable sum of money which it would have been difficult to provide. I should have thought that the way this country has maintained the increased standard of living —even through the slump years— was putting upon industrialists the biggest burden they can safely bear, without a last straw which would so cripple industry as to throw tens of thousands out of employment.

The agitation for the change in the basis of motor-car taxation has also received the consideration of your Council. We felt that it was not for us to express an opinion on this except from one point of view, and that was the position of benzole. It seemed to us that if petrol were taxed there must be included a tax on benzole. The Council, therefore, called the attention of the Chancellor of the Exchequer to this, and pointed out the disastrous effect on Chemical Industry, and in particular on the Dyestuffs Section if a tax were placed on benzole. I am glad to say that no such taxes have been proposed in the Finance Bill which is at present before the House.

I pass from what may be called negative or obstructive action on the part of your Council to more positive work. First, I shall refer to the Rating and Valuation Act of 1925. I need only remind you of the action taken by the Council during the passage of this Bill through the House and of the striking and very valuable part (N)ayed by one of my colleagues—Dr. Clayof mo. When the Bill received the Royal ... we all knew that the measure of ... had gained could only be fairly ... when the Committee which had ...nged for under Section 24 had re... You are familiar with that Report will ...will ...member it as another classi... s that this det... a minority being right. weight of B... fact, appeared to be the only person with a grasp of what the Act really intended. The publication of the Report—notwithstanding the reservation of the Chairman—caused a feeling of consternation among industrialists. A reasoned protest was lodged at once with the Minister of Health, and in the result we have the Order of May 20, 1927, which meets most of the points raised by the Association. In this matter we co-operated with a number of other bodies and I think we are entitled to take a considerable amount of credit for the result of our action.

I cannot be quite as complacent with regard to the Merchandise Marks Act, 1926. While opinions in the chemical trade are somewhat divided on the question of the effect of the Merchandise Marks Act, 1927 on home trade, there is certainly no question as to the reception that is being given to the efforts of the Board of Trade in explaining and ameliorating some of the many difficulties which have arisen in connection with the Act.

With reference to the Safeguarding of Industries Act, I have little to add to what is already in the Report. My silence may be taken as a reflection of the quiet which has prevailed since the provisions of Part I of the Act were extended by the Finance Act of last year for a further period of ten years.

The Preservatives in Food Regulations have provided us with one of those examples with which we have become painfully familiar of legislation by reference.

On the other hand, your Council has found a refreshing open-mindedness in the negotiations which have taken place between some of our members and a Joint Committee representing the Medical Research Council and the Department of Scientific and Industrial Research on the questions of Chemotherapeutic and Biochemical Research. It is impossible even to touch on everything in our Annual Report, but there is one subject which is so closely related to this that I feel I must mention it. I refer to the Regulations which have recently been issued under the Therapeutic Substances Act. We have had prolonged consultations on these Regulations. We are here dealing with a new type of problem, and I have no doubt time will show that in practice some of the Regulations will require modification. This has already been anticipated, and we have the assurance of the Minister of Health that when such time arrives he will not hesitate to consider their revision. Manufacturers of bona fide therapeutic substances wel-

come the Act, which, if administered in the spirit in which the Regulations appear to have been drafted, will be helpful to manufacturers as well as beneficial to the community.

Before leaving this section of what I have to say to-day, I would call your attention to the paragraph in the Report which deals with a certain Inter-Departmental Committee set up to consider the question of alcohols in Industry. This Committee met some time ago. With every courtesy and in a most painstaking manner, it examined carefully the evidence presented on behalf of this Association. There is every reason to believe that such a Committee would present a very valuable Report. Valuable not only to the Government but to Industry as well. Yet, gentlemen, I have to tell you that all our efforts to obtain a copy of this Report have failed. I presume the Chancellor of the Excheques has authority to print or to withold it. Possibly his preoccupation with his Budget has prevented his even considering our request. I do, however, hope most sincerely, that the suppression of this Report and the substitution of two Parliamentary Answers for it will not be accepted by the Chancellor as a proper method of treating our Industry. (Hear, hear.)

(To be Concluded Next Week.)

General Notes.

FIRE-DAMP EXPLOSIONS: "RING-RELIEF" DEVICE.

A third Report* on means of preventing the flames of fire-damp explosions within the casing of electrical apparatus from passing to the outside atmosphere has just been published. It deals with the so-called "ring-relief" device, which it is intended to provide additional means of pressure-release when the casings are of large volume, and neither flange nor perforated plate protection, described in the first and second Reports, is considered to be adequate. In principle, the ring-relief device consists of a number of metallic rings, separated one from another by narrow, radial distance pieces, assembled in the form of a cage and held securely in position by a circular brass end-plate and bolts connecting the end-plate with the casing. The interior of the casing thus communicates with the outer air through the series of gaps formed by the separation of the rings.

The general conclusion to be drawn from the experiments described in the Report is that the ring-relief device provides satisfactory means of releasing the pressure from a fire-damp explosion within the casing of mining electrical apparatus and, at the same time, of preventing the passage of flame.

The work was carried out jointly under the Safety in Mines Research Board and the British Electrical and Allied Industries Research Association.

* Safety in Mines Research Board Paper No. 35, H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2. Price 1s. net.

FUEL RESEARCH REPORTS.

The Report* of the Fuel Research Board for 1926 contains a review of the more outstanding events connected with their work. The year was notable for the issue of the Report of the Royal Commission on the Coal Industry, and for the lengthy stoppage of the mines which hampered much of the experimental work in progress. The Report deals with the progress of the Physical and Chemical Survey of the National Resources, which is gradually extending its activities to new areas, and of the study of methods of sampling and analysis of coal. The experimental work on low temperature carbonisation of coal proceeded throughout the year, and satisfactory progress was made. The arrangements made with the Gas Light and Coke Company for further development on a commercial scale of the plant designed at H.M. Fuel Research Station are described.

The Report of the Director of Fuel Research for the same period gives fuller retails of the work in hand and the progress made; special attention may be drawn to the work on low temperature carbonisation, the production of oil from coal by methods other than carbonisation, and the study of metallurgical coke.

* Report of the Fuel Research Board for the Year 1926, with Report of the Director of Fuel Research. Published for the Department of Scientific and Industrial Research by H.M. Stationery Office. Price 1s. 3d. net.

PETROLEUM MONOPOLY ESTABLISHED IN SPAIN.

The *Gaceta de Madrid*, of 30 June contains a Royal Decree-Law dated 28 June providing for the establishment in Spain of a State monopoly of the importation, industrial manipulation, storage, distribution and sale of the liquid mineral combustibles and their derivatives which form Group 3 of Class I. of the current Customs Tariff. The monopoly will control the drilling for, or production of, these oils in Spain, and also the importation and sale of any other liquid combustibles of mineral or vegetable origin. It will have jurisdiction over the whole of Spain and the Balearic Islands, and may be extended to the Canaries and Spanish North America.

The monopoly, to be valid for 20 years, is to be administered by a Company which is to be wholly Spanish in capital and control and will be granted to the most favourable offer received by 1 September, 1927.

FUTURE PROMOTION OF JOINT STOCK COMPANIES IN EGYPT.

A Decision of the Egyptian Council of Ministers was published in the *Journal Officiel* of 23 June in regard to future applications for the registration of Joint Stock Companies. Hitherto such applications have had to conform with the conditions prescribed in Decisions of the Council of Ministers of 17 April, 1899, 3 June, 1906, and 18 July, 1923. The terms of the last-mentioned Decision, which were published in the *Board of Trade Journal* of 18 October, 1923, have now been abrogated and replaced by the new Decision, which provides as follows :—

(1) The board of directors shall include at least two members of Egyptian nationality.

(2) Excluding workmen, the personnel of the company must include one-fourth of Egyptian nationals. This requirement extends to any person occupying the situation of clerk, bookkeeper or any other administrative or technical post under the company.

(3) In any public issue of shares, or debentures, at least one-fourth of the total issue shall be reserved for public subscription in Egypt, four-fifths of such being reserved for Egyptians. In any instance where the proportion of one-fourth of the issue thus offered to the public is not entirely taken up in the period fixed, the Council of Ministers shall be empowered to extent the period for a further term not exceeding three months or to waive, according to circumstances, this condition.

(4) Any share or debenture having been offered for public subscription must, within a period of one year at most after the date of issue, be presented for quotation on the Egyptian Bourse under the conditions of the Regulations of such Bourse.

(5) Documents establishing the annual situation of the company (balance-sheets, profit and loss accounts, reports of directors and auditors) must be published in full in two daily newspapers (one in Arabic and the other in foreign language) circulating in the place where the general meeting is to be held, and at least 15 days before the date of such meeting.

MUNICIPAL TRADING : SUCCESSFUL ACTION AGAINST ITS EXTENSION.

Traders generally throughout the country will be interested in successful action which has just been taken by a private firm against the development of municipal trading.

The matter started some twelve months ago at Dundee in connection with the production and sale of the residual products resulting from the manufacture of gas by the Dundee Corporation. One of these products is coal tar, to the manufacture of which no exception was taken; but the Corporation went further and installed a special plant for the manufacture, by the blending of coal tar with bitumen, of a composition suitable for road construction and other purposes. The bitumen necessary for this mixture, of which it comprised about 20 per cent., was purchased by the Dundee Corporation from outside sources and the mixture itself had characteristics quite distinct from those of unmixed coal tar.

At the same time the Corporation attempted to get constitutional authority for their activiies and, in accordance with Scottish procedure, sought to obtain the necessary powers by a Provisional Order. The clauses in the Order embodying the proposals were objected to by a Dundee firm, Messrs William Briggs & Sons, Ltd., manufacturers of bituminous specialities, who lodged a petition against them on the grounds that the Dundee Corporation were in effect going far beyond the powers which Parliament had hitherto granted to gas undertakings.

CANADA, SIXTY YEARS AFTER CONFEDERATION.

According to the Royal Bank of Canada, in July, 1927, Canada celebrated the Sixtieth Anniversary of Confederation, and it is appropriate at this time to review the general development of the country. The importance of Canadian wheat has received wide recognition; dairy products have a value of $250,000,000 a year; the newsprint industry leads the world. Canada stands first in the production of asbestos, nickel and cobalt; third in gold and silver, and her known coal reserves are exceeded only by those of the United States and China. The country stands sixth among the great nations in total value of both imports and exports, and is excelled only by New Zealand in per capita foreign trade. Three great transcontinental railways and shipping lines, which sail all seas, transport her produce. At no time in Canadian history has the record of achievement been more convincing and at no time in the past have the auguries of the future been more favourable than in 1927, the Sixtieth Anniversary of Canadian Confederation.

It is wise to pause long enough to secure perspective of past accomplishment before attempting to summarise the present. Sixty years ago, Canada had a population of three million; foreign trade amounted to $132,000,000; the annual value of mineral production as late as 1886 amounted to $10,000,000; and during the first ten years of Canada's life as a nation the wheat crop did not exceed 25,000,000 bushels. At that time, annual imports of wheat and flour exceeded exports by nearly 9,000,000 bushels.

To-day, Canadian foreign trade is twenty times as large as at the time of Confederation; manufactured products twenty times as valuable; the wheat crop sixteen to twenty times as large, and the ratio of increase in other agricultural products even greater. Mining products now have a value of $225,000,000 and foreign trade amounts to about $2,800,000,000 a year. Many of the older people now living throughout the country have vivid remembrances connected with their share in this rapid growth. In the West, the settler's hardships in new territory now bear fruit in such items as the $500,000,000 grain crop of 1925, or perhaps a better figure would be the total value of the field crops which amounted to more than $1,150,000,000 in that year.

BRITISH COLUMBIA INCREASING ITS PRODUCTION OF HOPS.

Hop production in British Columbia has grown to such proportions that the hop growers' chief problem this year will be to secure sufficient pickers to handle the present crop. No less than 6,000 pickers will be needed to handle the hop harvest of the Fraser Valley.

In the Sumas reclaimed area alone, 1,500 pickers will be needed to handle the output of new hop lands, and twice that number will be required next year when newly planted acreage comes into active production.

British Columbia will ship hops to new markets in Australia this year for the first time, under plans announced at the Department of Agriculture. Samples of the local product sent to Australian brewers have been tested and found excellent and orders are expected to follow.

The Dominion Bureau of Statistics reports that the area under hops in British Columbia in 1926 was 594 acres with a total yield of 966,438 lbs., worth $367,246.

MERCHANT NAVIES OF THE WORLD.

In a review of Lloyd's Register Book for 1927-28 is shown the increase and change in character of the world's merchant shipping since 1914. The merchant fleet of Great Britain and Ireland comprises over 30 per cent. of the world tonnage and nearly 38 per cent. of the ocean-going tonnage available for general cargo and passenger purposes.

CANADA'S GOLD PRODUCTION—REVISED FIGURES FOR 1926.

According to a report just issued by the Dominion Bureau of Statistics at Ottawa, Canada's gold production in 1926 again established a new high record with a total of 1,754,288 fine ounces which, valued at the standard rate of $20.671834 per fine ounce, was worth $36,263,110 as against the 1925 production of 1,735,735 fine ounces, worth $35,880,826.

Ontario contributed 1,497,215 fine ounces, an increase of 36,176 ounces over the total for 1925 and made a new high production mark for the province. The Porcupine field accounted for 1,145,564 fine ounces.

TRANSACTIONS OF THE ROYAL CANADIAN INSTITUTE, VOL. XV, 1926.

In the contents are included :—

Part I.—" Notes on the Nudibranchiate Mollusca from the Vancouver Island Region (Plates I and II),' 'by Chas. H. O'Donoghue; " The Physical Basis of Life," by D. T. MacDougal; " A Mathematical Principle of the Gill Form of Mushrooms," by C. D. Miller; " The Distribution and Structure of the Islands of Langerhans in Certain Fresh-Water and Marine Fishes (Plaes III and IV)," by N. A. McCormick; " Sudies in Botrytis (Plates V to IX)," by G. H. Berkeley; " Conjugation in Spirogyra (Plate X)," by Francis E. Lloyd.

Part II.—" The Nature, Causes and Prevention of ' Nervous Breakdowns,' " by Lewellyn F. Barker; "Maturation and Conjugation in Spirogyra (Plates I to IV)," by Francis E. Lloyd; " A List of the Nudibranchiate Mollusca Recorded from the Pacific Coast of North America, with Notes on their Distribution," by Chas. H. O'Donoghue; " The Nearctic Species of the Genus Rhaphium Meigen (Dolichopodidae, Dipt.)," by C. H. Curran; " Representation of the Branches of an Algebraic Function of Several Variables," by J. C. Fields.

WHOLESALE PRICES IN FRANCE, GERMANY, BELGIUM AND ITALY.

COMPARISON OF RELATIVE MOVEMENTS.

The index numbers for May revealed a considerable decline (4.8 per cent.) in wholesale prices in Italy, and a further moderate decline (1.2 per cent.) in France. German wholesale prices, which had been falling since the beginning of the year, took an upward turn in May, when the general index was 1.7 per cent. above the April average, while the Belgian index, after falling 12 points in April, rose again by 2 points to 848. Owing to the employment of different base periods, the index numbers are not strictly comparable in magnitude as between one country and another, but some comparison can be made regarding the relative movement of prices.

REVISED STATISTICS ON CANADA'S NICKEL PRODUCTION, 1926.

Finally revised statistics on nickel production in Canada during 1926 as reported by the Mining, Metallurgical and Chemical Branch of the Dominion Bureau of Statistics show an output of 65,714,294 pounds, valued at $14,874,163 as compared with 73,857,114 pounds valued at $15,946,672 in 1925.

COLOUR IN THE SUGAR INDUSTRY. PART I. COLOUR NOMENCLATURE IN THE SUGAR INDUSTRY. PART II. COLORIMETRIC CLARIFICATION OF TURBID SUGAR SOLUTIONS.

By H. H. PETERS AND F. P. PHELPS.

In the vast bibliography of Beer's Law there occur only scant references to the absorption spectrum of definitely specified types of sugar syrups. No systematic investigation of absorption spectra of different chemical methods from the various grades of technical sugar products, either beet or cane, appears to have been undertaken at any time previous to this investigation by the Bureau of Standards. Therefore, the exceedingly great difficulties inherent in any attempt to gauge the true colour value of saccharine solutions by means of precise spectrophotometric methods have heretofore not generally been fully appreciated. These difficulties arise because of the different degrees of optical inhomogeneity of such solutions. Yet the precise evaluation of colour is an indispensable necessity for commercial and sugar technological reasons. In order to avoid misunderstandings and confusion, the nomenclature and terminology of precision photometry are given separately from the rest of the paper.

A spectrophotometric study of absorption spectra of sugar solutions led to the discovery that any variation in chemical methods of preparation and clarification of solutions for an optical precision analysis causes, in turn, variations in transparency and observed light intensities. The true colour value of the solute appears rather doubtful and seems to be attainable only after continued and extended research. This paper contains the detailed description of an improved method of preparation and clarification. The latter aims at the production of stable degrees of transparency and dispersion of the colloidal dispersoids. A discussion of spectrophotometric data, including certain important ratios, follows the chemical part. The colour value of the solute is defined in terms of a unit quantity of saccharine dry substance by the spectrocolourmetric equivalent of intensity and quality of absorption at separate wave lengths, which at λ 560 $m\mu$ becomes a measure of colour and concentration of colouring matter over the full spectrum.

A series of papers to follow this paper will present further analytical details of the investigation in its chemical and optical aspects.—(*U. S. Standards, Technologic paper, No.* 338).

OME POINTS FROM "UNBRANDED."

Messrs. Rayner and Co., Patent and Trade Mark Agents, of 5, Chancery Lane, London, have just issued the 2nd edition of their booklet entitled UNBRANDED,* which contains some very useful information on the value of Registered Trade Marks and the Branding of goods pointing out the value of Registered Marks both to the manufacturer and the buyer.

It is suggested this subject is not sufficiently appreciated in the industry of practical chemistry and that while we are all willing to insure our factories from fire and other damage we do not insure the Goodwill of our business by procuring Registered Trade Marks to defend our rights from infringement.

All successful bnsiness men have recognised the importance of Trade Marks for their goods when building up a sound trading concern as these Marks ensure the return orders for the makers' productions, and these Trade Marks or Brands are the cheapest form of insurance that any commercial business can obtain to make certain that the manufacturer or trader gets full return orders that the quality of his goods entitle him to.

The Goodwill of a business is greatly increased by the position of these Marks and it is to be remembered that Goodwill is more than the day's turn-over—something for the future and progress and the steady increase of trade. The Goodwill is the "to-morrow" of a business, and those who work for progress work for to-morrow. If the Goodwill is insecure future prosperity is doubtful.

When goods are exported to the colonies or foreign countries, it is very desirable that Trade Marks be Registered in those countries or the enterprising foreigner may produce and sell in these countries goods very similar to those made by the original exporter, but inferior in character and cheaper, and so the business may be ruined and with no redress.

Registered Trade Marks are granted in Great Britain by H.M. Patent Office and the fees are very small compared to the value obtained. The services of an expert are essential to avoid difficulties in obtaining Registration and to comply with the regulations of the Patent Office.

* The Booklet referred to is issued by Messrs. Rayner & Co., Patent Agents, of 5, Chancery Lane, London, who will send a copy free to any of our readers who will send their address on a post card.—ED., CHEM. NEWS.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

18,924.—Chemische Fabrik auf Actiem vorm. E. Schering.—Process of and mannfacture of iodine substituted benzonitriles. July 15th.

18,797.—Compagnie de Bethune.—Catalyzers for synthesis of alcohols. July 15th.

18,850.—Deutsche Gold-un Silber-Scheidcanstalt vorm. Rossler.—Process for production of alkali hydride. July 15th.

18,824.—Haynes, P. E.—Manufacture of carbon dioxide. July 15th.

18,416.—Bakelite Corporation.—Phthalic anhydride glycerol resime, etc. July 11th.

Specifications Published.

256,243.—I. G. Farbenindustrie Akt-Ges.—Manufacture of 3 : 4-Benziminolone-arsenic acids.

262,408.—Rehnania - Kunheim Vereim Chemischer Fabriken Akt.-Ges.—Process for the production of solid ammonium carbonate from its components.

266,729.—Wiberg, F. M.—Method of reducing to carbon monoxide the carbonic acid gas content in gases.

268,817.—I. G. Farbenindustrie Akt.-Ges. Manufacture of alkali bisulphate.

Abstract Published.

271,767.—Hydrogen; hydrocarbons.—Petrole Synthetique Soc. Anon., 6, Rue d'Agenson, Paris, and Folliet, A., Villa la Terrasse, Lozere, Seine-ot-Oise, France.

In obtaining hydrogen and hydrocarbons, particularly olefines, of higher carbon content than methane by the process of the parent Specification, according to which a thin stream of methane is gradually and uniformly heated and the reaction products are cooled suddenly and kept under reduced pressure until completely cooled, a reduced pressure of 20-50, preferably 40-50, cm. of mercury is applied, and the gas is heated between walls or in tubes made of metal, such as iron or steel, coated with refractory material, such as silica or carborundum.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

OPOJEX.

481,424.—Chemical substances prepared for use in medicine and pharmacy.—British Organotherapy Company, Limited, 22, Golden Square, Regent Street, London, W.1. July 20th.

NUCKLETS.

481,590.—Chemical substances prepared for use in medicine and pharmacy.—Cuxson, Gerrard & Co., Limited, 26, Fountain Lane, Oldbury, Worcestershire. July 20th.

MOS-KY.

481,664.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—The Asiatic Petroleum Company, Ltd., St. Helens Court, Great St. Helens, London, E.C.3. July 20th.

AGELA.

480,227.—Chemical substances used in manufactures and photography.—British Gels, Limited, Millmarsh Lane, Brimsdown, Middlesex. July 20th.

GEN. INDEX TO THE

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This large volume contains a detailed Index to the first 100 volumes of the *Chemical News*, and will be found of great value to all interested in Chemical, Engineering, Electrical, and General Scientific subjects. It has been compiled with great care, is handsomely bound in red cloth, and has been produced at great expenditure of time, labour and money. Carriage paid, Great Britain, 21/- net; Carriage paid to Foreign Countries and the Colonies, 28/- net.

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A NEW METHOD FOR MEASURING VAPOUR-DENSITIES.*

By PHILIP BLACKMAN.

I.

The apparatus consists of a short piece of burette or other graduated tube (see Note 1), narrowed off and open at one end, with a long and narrow tube (see Note 2), joined on at the other end. The side tube is bent into U-form at the bulb and the other end is bent back into an inverted U-form. The longer the side tube is and the greater the capacity of the bulb the greater is the weight of the substance to be experimented on that can be used.

The apparatus is cleaned and dried, and the bulb is nearly filled within two or three cms. from the open end with pure dry mercury (see Note 3). A small quantity, weight W (see Note 4) of the substance to be experimented on (the specific gravity S of which is required to be known) is weighed out in a small tube (see Note 5) and introduced into the bulb, which is immediately sealed; and when it has cooled to room-temperature t_1 °C. (to be noted), the position of the mercury in the bulb is noted (*e.g.*, with a fine file-scratch, or in relation to graduation marking on the bulb or side tube if there be any) so that the volume v_1 of the enclosed air can be later on determined; and the difference in height, m_1, between the mercury levels in the bulb and side tube is measured.

* Compare *Journal of Physical Chemistry*, 1911 xv, 870; *Berichte*, 1908 XLI, 4144; *Chemical News*, 1916, CXIV, 80.

The external atmospheric pressure p_1 is noted.

The bulb is totally immersed in a suitable medium (*e.g.*, glycerin, paraffin-wax (see Note 6)) in a deep vessel and heated to a temperature t_2 °C (kept constant) sufficiently high to vaporize completely the substance. (*As the substance is being vaporized under a pressure greater than the ordinary atmospheric pressure*, t_2° will be above the ordinary normal B.P. of the substance). The position of the mercury level in the bulb is noted in order that the volume v_2 of the enclosed gases may be subsequently measured and also that the difference in height m_2 between the mercury levels in the bulb and side tube may be determined; the external atmospheric pressure p_2 is observed (see Note 7).

The U-bend at the free end of the side tube is to enable the overflow of mercury to be easily caught.

The apparatus is removed, the mercury is emptied out, and m_3 is measured. The side tube is cut off from the bulb, which is inverted and mercury is poured in from a burette in order to determine v_1 and v_2 (see Note 8). The room-temperature t_3° is observed (see Note 7).

All measurements, as well as the heating, are carried out with the apparatns in a vertical position.

This method cannot be used with substances which react upon mercury.

THEORY.

It is assumed that 1 gram of hydrogen at 0° C. and 760 mm. pressure occupies 11160 c.cm.

g (see Note 9) is the vapour-tension of mercury at t'_3; 0.000026 is the coefficient *of cubical expansion of glass (see Note 10.)*

Let d be the vapour-density of the substance.

The volume of the substance at $t_1°$ = w/s; hence the volume of the air at $t_1°$ =

$$v_1 - \frac{w}{s}$$

and its pressure is $p_1 - m_1$. This air at $t_2°$ occupies the volume

$$v_2(1 + [t_2 - t_3]\,0.000026),$$

and its pressure is

$$\frac{(p_1 - m_1)(v_1 - \frac{w}{s})(273 + t_2)}{v_2(1 + [t_2 - t_3]\,0.000026)(273 + t_1)} \quad (1$$

The vapour-pressure of the substance is

$$\frac{11160 \times 760\,w\,(273 + t_2)}{273 d v_2(1 + [t_2 - t_3]\,0.000026)} \quad . . . (2$$

But the internal pressure = the externa pressure; therefore (1) + (2) + g = $p_2 + m_2$ from which on simplification

$$d = \frac{31068 g\, w\,(273 + t_1)(273 + t_2)}{(p_2 + m_2 - g)v_2(1 + [t_2 - t_3]0.000026)(273 + t_1) - (p_1 - m_1)(v_1 - \frac{w}{s})(273 + t_2)}$$

For ordinary purposes $\frac{w}{s}$ may be omitted from the manipulations and calculations without greatly affecting the accuracy of the calculated results.

II.

The whole apparatus may be made from a disused burette, *i.e.*, without having to join on a side tube, but in this case it will be necessary to fill the open limb with mercury before the heating takes place, thus necessitating the use of a great quantity of mercury; but this disadvantage is perhaps compensated for by the possibility to extend the height of the open limb by inserting a cork with a long narrow tube (flush with the cork) so as to increase the pressure and so make it possible to use a greater quantity of the substance to be experimented on than would otherwise be possible (see carbon-tetrachloride in Table I), but this can also be achieved with the first form of the apparatus by the addition of one or more narrow tubes.

III.

The smallness of the bulb does not permi the vaporization of any considerable weigh of substance. This can be overcome b joining on to the short piece of burett tubing a wider piece of tubing or a smal flask, to the other end or base of which i joined another piece of burette tubing o other tube (without which it will be difficul to fix the v_1 position) the end of which i drawn off narrow for the insertion of th weighing tube and for quick sealing. Thi apparatus requires a large quantity c mercury (see ether and benzene, Table] and all results in Table II.

IV.

It will be seen that in all the precedin forms of the apparatus the vaporization i carried out under increased pressure. I however, the side tube be bent short dowr wards, so that its free end is below the bul and is allowed to dip under mercury in basin, the vaporization can be carried ou under reduced pressure. In this case th term ($p_2 + m_2 - g$) in the formula must b written ($p_2 - m_2 - g$), so that

$$d = \frac{31068\, w\,(273 + t_1)(273 + t_2)}{(p_2 - m_2 - g)v_2(1 + [t_2 - t_3]0.000026)(273 + t_1) - (p_1 - m_1)(v_1 - w/s)(273 + t_2)}$$

When a determination is thus carried out under reduced pressure, it is all the more necessary to use a very small quantity of the substance, or which is much more desirable by some means as already detaile increase the bulb content. (Result Table II.)

TABLE I.

	p_1 mm.	p_2 mm.	m_1 mm.	m_2 mm.	g	t_1	t_2	t_3	v_1 c.cm.	v_2 c.cm.	s	w grams	d full formula	d omit w/s	theory
CH_3I	760	761	150	743	—	18	80	19	2.05	8.15	2.1	0.0638	64.9	65.0	70.9
C_5H_5N	758	758	148	540	9	17	180	19	1.85	9.20	1.0	0.0285	39.5	39.6	39.5
$C_2H_4Cl_2$	758	758	120	650	—	17	100	18	2.45	7.30	1.2	0.0355	49.5	49.6	49.4
C_2H_5I	761	761	131	637	—	16	100	18	2.35	6.50	0.9	0.0440	70.5	70.9	77.0
$CH_3.OH$	759	759	111	473	—	16	100	17	1.95	12.15	0.8	0.0185	16.0	16.0	16.0
C_2H_5OH	760	760	115	711	—	16	100	18	2.55	9.85	0.8	0.0239	22.3	22.4	23.0
C_2H_5Br	768	769	108	688	—	15	60	18	2.60	7.75	1.4	0.0452	50.0	50.1	54.5
$CH_3.CN$	758	757	121	567	—	18	100	19	2.10	11.80	0.8	0.0219	18.2	18.2	20.5
$CHCl_3$	763	763	94	488	—	19	100	20	2.75	9.20	1.5	0.0460	57.9	58.1	59.7
$(CH_3)_2CO$	763	762	105	649	—	16	100	17	2.15	10.45	0.8	0.0324	28.9	29.1	29.0
$(C_2H_5)_2O$	760	760	97	673	—	17	100	19	2.45	57.55	0.7	0.2585	37.0	37.2	37.0
$C_6H_5.CH_3$	765	764	114	691	6	17	170	18	2.45	7.00	0.8	0.0260	46.0	46.1	46.0
$C_5H_{11}.OH$	764	764	102	613	4	19	160	20	2.75	8.05	0.8	0.0280	44.7	44.9	44.0
CCl_4	760	760	117	1421	—	16	110	18	2.55	10.95	1.6	0.1408	76.9	77.0	76.9
$CH_3.CO_2C_2H_5$	768	768	121	722	—	16	100	18	1.80	7.35	0.9	0.0305	37.2	37.4	44.0
$CH_3.COH$	758	758	115	626	—	13	80	15	1.65	10.10	0.8	0.0287	24.7	24.8	22.0
C_6H_6	746	747	110	688	2	15	140	17	2.70	48.35	0.9	0.2043	39.0	39.1	39.0

TABLE II.

	p_1 mm.	p_2 mm.	m_1 mm.	m_2 mm.	g	t_1	t_1	t_3	v_1 c.cm.	v_2 .cm.	s	w grams	d full formula	d omit w/s	theory
$CH_3.CO_2C_5H_{11}$	759	760	158	233	4	17	160	19	2.75	28.45	0.9	0.0556	59.8	60.1	65.0
$C_6H_5.N(CH_3)_2$	753	754	143	367	18	18	200	19	2.15	37.05	0.9	0.0459	57.9	58.1	60.5
$C_6H_5.NH.CH_3$	764	764	107	208	18	14	200	16	2.50	27.45	0.9	0.0486	52.6	52.8	53.5
$C_6H_5.Br$	768	768	118	341	3	15	150	17	2.10	36.75	1.5	0.0817	78.3	78.8	78.2
$C_6H_5.NO_2$	760	760	111	413	25	18	210	19	2.55	37.75	1.2	0.0391	61.7	62.0	61.5
C_9H_7N (quinoline) ...	751	751	99	218	59	15	240	16	2.15	27.05	1.1	0.0430	65.6	66.0	64.5
$C_6H_5.OH$	758	758	123	310	13	14	190	16	1.90	39.90	1.1	0.0508	47.0	47.2	47.0
$C_2H_5.OH$	760	760	109	109	45	15	230	17	3.00	41.35	0.8	0.0322	23.0	23.1	23.0
$C_6H_5.COH$	761	762	84	232	13	16	190	17	2.00	37.55	1.0	0.0673	55.6	55.9	58.0
$C_6H_5.COCl$	768	768	147	308	18	18	200	19	1.95	36.85	1.2	0.0695	70.6	71.0	70.2
$C_6H_4(CH_3)_2$ (m-xylene)	760	761	136	158	2	15	140	16	1.65	40.20	0.9	0.0952	58.0	58.2	53.0
$C_2H_4Br_2$	758	759	121	484	1	18	120	20	2.10	41.40	2.2	0.0461	58.7	58.0	53.7
$C_{10}H_7Cl$ (α-chloro-naphthalene) ...	763	763	100	283	97	16	260	18	1.90	37.65	1.2	0.0601	81.2	81.6	81.2
$C_5H_{11}.NO_2$	761	760	136	521	2	18	140	20	2.35	38.85	0.9	0.0318	56.8	57.1	58.5
C_6H_6	757	756	95	87	1	16	120	18	1.65	28.50	0.9	0.0564	39.0	39.1	39.0
$(C_2H_5)_2O$	763	763	112	62	1	17	130	18	1.85	30.05	0.7	0.0577	37.1	37.2	37.0
$(CH_3)_2CO$	760	760	103	70	33	15	220	18	1.65	32.65	0.8	0.0374	29.0	29.1	29.0
CCl_4	761	761	130	81	76	16	250	17	2.25	26.30	1.0	0.0687	76.9	77.2	76.9

NOTES.

1.—(*The Graduations*). — The graduations on the tube are merely to aid in observing the positions to which the mercury rises in order to determine v_1 and v_2. Any other means for noting these positions will do equally well.

2.—(*The Side Tube*).—The tube leading from the bulb should have a wide bore. If the bore is very narrow, then when the bulb is sealed there is a reduction of pressusre in it causing the mercury to rise in the bulb, this rise being far greater than the volume of mercury in the side tube and causing air to be sucked into the bulb; this is really of no consequence except that it is desirable to keep v_1 small on account of the small total capacity of the bulb.

3.—(v_1).—v_1 should be made as small as possible, so that at $t_2°$ the pressure exerted by the air may be small.

4.—(w).—When a substance, the vapour-density of which is not suspected, is experimented on it is advisable to carry out first a trial determination in order to discover what weight of it can be used with maximum advantage. In all cases it is best to provide beforehand that the upper end of the bulb be somewhat long so that if necessary it may be easily opened and the operations repeated.

5.—(*The Weighing Tube*.)—The weighing tube is best made from thin test-tube glass drawn out very fine so that it is of inappreciable volume. It consists of a narrow tube closed at one end into which the substance is put, and this is pushed open end first into a similar but slightly wider tube. After the weighing it should be handled with forceps and not with the fingers to avoid evaporation and loss of the substance.

6.—($t_2°$).—When a substance will evaporate below 100°, especially under reduced pressure, water is a convenient heating medium.

7.—(p_1, p_2, $t_1°$, $t_3°$).—Generally $p_1 = p_2$ unless the heating takes place much later than the sealing up of the bulb. Similarly $t_1°$ and $t_3°$ will rarely differ greatly.

8.—(*Determination of* v_1 *and* v_2).—Allowance must be made for the convexity of the mercury meniscus. The methods (and full mathematical explanation) for doing this will be found in full in the *Journal of Physical Chemistry*, 1920, XXIV, pp. 275-276, Note 5.

9.—(g).—For temperatures ($t_2°$) below 100° the values for g are negligible.

10.—(0.000026).—The coefficient of linear expansion of glass is taken as 0.0000086 and therefore the coefficient of cubical expansion is 0.0000086 × 3 = 0.000026.

Hackney Technical Institute,
London, E.8.
1915-1916.

THE ASSOCIATION OF BRITISH CHEMICAL MANUFACTURERS.

ELEVENTH ANNUAL MEETING.

(*Continued from Last Week.*)

Mr. Perry (Vice-President) in seconding, said: "It has become customary with us for our Chairman to sit for two years, so I shall look forward with pleasure to hearing Mr. Hill again this time next year. At the same time I think I shall only be expressing the feeling of all present if I assure Mr. Hill that he has completed the first round with skill and striking success. (Hear, hear.) In fact, gentlemen, I can only find one hole in the course of the Report in which he has left me any opening at all. I refer to the paragraph dealing with the League of Nations Economic Conference. In this particular paragraph dealing with the League of Nations Economic Conference at Geneva, I think our modesty has for once prevented our writing the whole truth in this paragraph. At the close of last year there was produced at Geneva a German Monograph on Chemical Industry. This document was sent to the A.B.C.M., and your Council decided that the British point of view ought to be forthwith presented, and that another Monograph should be prepared. The Report goes on to say 'This was done.' Gentlemen, it may appear somewhat novel to some of you to produce a Monograph of the Chemical Industry of the World from the British point of view—*i.e.*, prepare and despatch it—within ten days, but to me it is one of the most brilliant pieces of work that our Association has ever done. (Hear, hear.) And I think we ought especially to congratulate our General Manager on the preparation of that Monograph. I would also like to add that I have personal evidence from friends of mine in America that the Monograph was greatly appreciated, and I think it is not saying too much to say that it had the effect of increasing not only the friendship but the respect of the American and other Delegates from chemi-

cal industries in different parts of the world who met our own representatives at Geneva. (Hear, hear.)

When listening to the Chairman's remarks upon Conferences in general, it struck me that the present trend towards combination of countries was likely to continue, and it seemed to me to be increasingly evident that industrial Associations such as ours will become even more essential than they have been. I quite agree with our Chairman that we cannot expect members, who have their own businesses to look after, to be going to Berlin, Rome, Geneva, Monte Carlo (laughter) for Conferences for lengthy periods and at all times, and, therefore, the Industrial Associations will have to possess a sort of professional diplomat whose duty it will be to attend and guard the interests of each industry. I feel, so far as we are concerned in the Chemical Industry, that we have only to go on as we have done to be adequately protected.

I have only one more word to say, gentlemen. I should just like to refer to the past year, because it is one that in my opinion will always be known as the birth year of the largest and most powerful combination that British Chemical Industry has ever known—I refer to Imperial Chemical Industries, Ltd. It is a pleasant vista to us all to see old enemies becoming new friends—to what I believe will be a lasting benefit to our nation. May we not here claim with some reason that the work of the A.B.C.M. during the last ten years has played no small part in bringing about the arrival of a better understanding, so essential to the success of this great undertaking?"

In the discussion which followed, Mr. T. Morson said he thought everyone realised that as individuals they were just about helpless in local matters, because they were in this particular respect disenfranchised. They had no power, or only very limited powers indeed, to get their Directors or members of the staff elected to these local bodies. In that respect, therefore, he would suggest that the Council might help very considerably by giving every support possible to any Bill that may be promoted to confer municipal franchise upon Corporations and Companies. Whether that had been done to any extent in the past he did not know, but it had not appeared, so far as he could see, in any of the reports. As a good many members would probably know, the London Municipal Society had issued monographs on that subject which gave in full detail information as to what had been done in the past. A Bill was promoted, but he supposed it met with the fate of a good many Private Members' Bills. He did feel that if an Association like theirs, co-operating with a large number of other similar associations throughout the country, could only get Members of Parliament to bring pressure to bear to get a Bill of that sort promoted it would help them very much and be the first step towards relieving the burden of the local rates. It would, at any rate, enable suitable men to be nominated to local bodies ,and that was their great difficulty at the present moment. He suggested that possibly the Council might think it worth their while to take such steps as would be useful in recommending members to form local associations of manufacturers in their districts. It certainly had been most successful in his own.

On the matter of social legislation he did not feel so well qualified to speak, but in connection with their local Association at Enfield he took the trouble to ask members what their figures were for the increase in their contributions under National Insurance. They did not seem to realise the very large increase in the amounts. It averaged out, among about fourteen members of their local Association, an increase of something like £130 to £140 per annum. That served a very useful purpose in drawing the attention of their local members to the fact, and it was hoped that something might be done. Government economy was now being achieved mainly at the cost of local rates. They were saving themselves by throwing a burden on local rates which, in the long run, is a very much more severe burden on manufacturers." (Applause).

The Rt. Hon. J. W. Wilson said he was very interested in Mr. Morson's comments on this particular paragraph in the Report ("Cost of National Social Services"). It was a thing that grows and grows. It was very difficult for Parliament to lay down any line in which the representation of limited companies could be adjusted in any way. At the same time a way might be discovered, and the object of the paragraph in the Report and the object of the last speaker's interesting remarks was in order that they as individuals should do what could. They should not lose sight of this subject. If everybody was compelled to vote, the results of the Municipal Elections would be very different from what they were. They were all apt to take lying down a thing that was out of sight, instead of each one doing his best. Manufacturers should endeavour to get one of their Directors or a member of the staff to represent them. They should do their best to find

the most moderate, level-headed business men to put forward on the Council. Many a man would respond to the call and come forward and go on to a local Council if he were pressed to do so. He thought that in many districts wherd a limited company had a large employment in the district anyone connected with the firm not necessarily a Director, would receive a great deal of loyal support from the employees without any pressure and without politics coming into the question at all. Again, help might be given as regards polling and facilities given for the workpeople to go to the poll, for instance in the dinner hour or some other time, and not leaving it until the moderate man says "I am going home to make myself comfortable." The enthusiastic man goes out and votes, and we see the result in election after election. When they looked at the results already alluded to, and when they came to compare their overhead charges with those experienced abroad, they realised how heavy was the cost, not only of the social legislation which to some extent relieved them from employing men when they were no longer able to give value in exchange for wages—he quite believed that the system of pensions was an economic advantage to the manufacturer: he had not to keep a man on doing odd jobs - but, apart from social reforms of that character, there were a lot of others, largely local ones. The local burdens were very often not known and not realised, but they were there all the same when it came to a comparison of their costs and their manufacturing burdens with those of other countries. The paragraph in the Report would do something by putting suggestions into the minds of members all over the country, and particularly in the smaller places, where influence could be more effectively used than in a great place like London.

He was most impressed by the report Sir Max Muspratt was able to give of the extraordinary unanimity at the Conference in Geneva of those 45 nations all over the civilised world with regard to the present condition of tariff walls in the south of Europe and the Central Provinces of Europe, which were created by the dozen. They had all been busily building up walls against themselves and courting disaster by that means. It was not necessarily a question of Free Trade *versus* Tariffs, but it was an example of how impossible it was in small communities to gain in that way the strength which they required. They did not want that. They wanted the United States of America and the United State of Europe to unite in a United States of Commerce. (Hear, hear.)

Sir John Brunner, in resposne to a request from the Chairman to give some account of his recent visit to Berlin, said that generally speaking the two Conferences were very useful, both directly and indirectly. They discussed a number of subjects, the main one of which was the subject of restrictions on imports and exports. He thought they could take it that the Germans felt that their system of tariffs was a hindrance to their expansion of trade. Naturally, every individual manufacturer who depends upon a trade wishes to have kept in the tariff items favourable to himself, and he would like to see everybody else under a system of Free Trade. That was the position in every country in the world. On the whole, they could see that there was a tendency in Germany to ask that restrictions on imports and exports all over the world should cease. They then had a discussion on tariffs from the point of view of classification and nomenclature. The chemical trade does not feel this question so acutely as some other trades. The other matter which was brought up was that tariffs were built up in very different ways. Some people in some countries based their classification npon the source of the item to be taxed. Others based it upon the uses to which the article was to be put in their own country. Apart from these differences of classification, there was an enormous difference in the wording of tariffs which made it extremely difficult for people who exported to all the countries in the world to find out what to manufacture at any particular period. Another matter of discussion was the question of double taxation in Germany and England, and they came to a resolution to press upon their respective Governments the necessity for doing away with double taxation in the two countries. That was a great hindrance to international trade. He believed that the two Governments were studying this question with the idea that some international agreement might be made. If Germany did it, then the idea would no doubt spread among other countries. The question of Fairs and Exhibitions was considered, the general feeling being that these Fairs and Exhibitions were absolutely and utterly overdone in the world. The opinion was expressed that they were very largely becoming a question of blackmail among the traders of various countries. These, shortly, were the results of their Confer-

ence. He believed the Conference would have very good results indirectly. They had had Conferences of another character at Romsey and Leverkusen which covered a great deal wider ground. He felt that these international conferences would result in better relations between themselves and Germany, and ultimately in better relations with other counries. He thought it was time that they should make every effort possible to eliminate all the traces of the late lamentable war. (Hear, hear.)

Mr. J. Deacon offered some criticism on the question of co-operation. There was nothing in the Report which showed any efforts were being made at co-operation. He thought that a scheme would be workable among the members of the Association if the quantities of their contracts over a year could be placed before the Committee, because, after all, we all had to face the difficulties of booking contracts and estimating their requirements, and the Committee could consider the advisability of allocation.

Mr. E. V. Evans said that he agreed with Mr. Perry that the Association must have played quite a large part in paving the way for the fusion of Imperial Chemical Industries,Ltd. Some of them, who by reason of their constitution or by reason of the nature of the manufactures they undertake could not hope to be favoured by being included in the future in this fusion, might have thought that the service the Association could render to the two-thirds capital ouside his fusion must of necessity be small as the result of this fusion. He must admit that at first he felt that the work of the Association would naturally be less now that so much of the chemical industry was fused together; but on second thoughts that opinion was entirely reversed, and they only had to read the Report, which spoke of the work done by Sir Max Muspratt and Sir John Brunner and that one-way traffic man through whom all Association matters go, the General Manager, to know that what the Association could do for them in the future would now be even greater than it has been in the past. He did feel now that the Association to-day could render very much more service to the two-thirds capital outside the fusion than he had originally thought, and he hoped that feeling would be shared by others outside.

Mr. F. H. Carr said he would like to make a brief reference to the Therapeutic Substances Act, of which mention had been made in the Report. The intention of that Act, as in many Government Acts, was entirely benevolent, but the Therapeutic Substances Act might, if properly handled, be more than a merely benevolent influence—it might do much to build up a particular branch of chemical industry in this country. The manufacture of therapeutic substances was an industry which was in its infancy at the present time, and it had an immense future before it. But, as in all such legislation, they were entirely dependent upon the spirit in which it was administered and the type of inspectorship which was imposed, whether or not it strangled the development of the industry. Its tendency and the spirit in which it is done should be all in the other direction. As an illustration of how it might work, the manufacture of insulin was very largely controlled in the same way as therapeutic substances would be in the future, and to-day the British industry had been raised to a standard of control almost foremost in the world; and so other therapeutic substances might have a much greater commercial value throughout the world if the Act was properly administered.

In another part of the Report reference was made to alcohol ,and he would say after much consideration and without any fear of contradiction that no single Act of any Government in this country ever did more harm to chemical industry than the attitude Governments had taken in the past with regard to alcohol. The Chairman had referred to the report or the account which has been given of the decision of the Alcohol Committee without their Report being issued. He hoped that the Association would continue to press for the Report until they got a clear understanding with the Government that they were doing all they possibly could to help the industry. He was merely connecting this action with the other Act, hoping that they would get the same kind of treatment in the way in which the alcohol regulations were administered. (Hear, hear.)

Sir William Pearce said he thought they had missed one point. No one had said a word about the very great improvement of the industry since the end of the war. He was sure it was to the advantage of the country that the situation had so greatly improved. When he remembered what was the position before the war of the dyestuffs industry in this country, and the position of synthetic organic chemistry, which was extremely critical, he thought the improvement was extremely marked. He was positive the greatest future lay with synthetic organic chemistry. Nowadays, they had every reason to congratulate themselves.

There was another reason why they could congratulate themselves, and that was upon the formation of Imperial Chemical Industries, Ltd. He dare say a good many people like himself, had felt a little trepidation with regard to their big brother. But he was sure they all realised that this formation was of great consequence and of great benefit, and he believed they all wished it a very successful career.

The Resolution was then put to the Meeting and carried unanimously.

Messrs. Feasey & Co. were re-elected Auditors.

The Chairman of Scrutineers, Mr. Miller-Jones, presented their Report.

Votes of thanks to the Council, the Scrutineers, and the Chairman, concluded the business.

General Notes.

CANADA'S PRODUCTION OF ABRASIVES.

In recognition of the growing importance of the Abrasive Industry, and the many enquiries received concerning the uses, sources of supply, preparation and markets of the numerous minerals and materials included under the description of abrasives, the Dominion Department of Mines has made an investigation resulting in a series of bulletins embracing the subject in all its phases.

The report is being issued in four parts, Part III. of which has just been published. This Bulletin deals with garnet, and is published by Mr. V. L. Eardley-Wilmot, of the Mines Branch.

"SMELTERS" TO MAKE SULPHURIC ACID.

A Press report states that the Consolidated Mining and Smelting Company of Canada will proceed immediately with the erection of a large contact process sulphuric acid plant. This plant will make sulphuric acid from the smelter fumes.

HALF-YEAR'S CAPITAL ISSUES.

Issues of new capital in the United Kingdom during the first six months of the year were appreciably larger than in the corresponding period of the past three years, the Midland bank returning the total at £159,693,919.

SOUTH AFRICAN TRADE IN JUNE.

The Standard Bank of South Africa report the receipt of a cable from their general managers, intimating that during June imports into the Union of South Africa amounted to approximately £5,362,000, and exports from the Union to about £5,318,000. The exports included native gold to the value of £3,586,000.

BRITISH INDUSTRIES FAIR.

Chemical Associations to Help.

All the leading associations in the chemical industry, including the Association of British Chemical Manufacturers, have received a letter from Mr. A. M. Samuel, Parliamentary Secretary to the Department of Overseas Trade, calling attention to the British Industries Fair, 1928, and particularly to the Chemical Section at White City.

"The Chemical and Allied Industries now provide one of the most important sections of the Fair and the Section attracts greater attention each year from visitors," Mr. Samuel writes. "The success achieved in recent years and particularly last year, moreover, has already induced a number of firms to consider participation for the first time in 1928. I am trying this year to make the Section thoroughly representative in all branches and I ask for the co-operation of your Association, particularly in the direction of securing new participants."

It is pointed out that some applications for space in the London section of the Fair of 1927 had to be refused owing to lack of accommodation. For that reason arrangements have been made to provide 100,000 square feet of additional space for 1928, 1929, and 1930. Publicity literature and methods have been completely overhauled and, with the help of His Majesty's Trade Commissioners, Commercial Diplomatic Officers and Consular Officers all over the world, an analytical examination has been made of lists of overseas buyers, the number of whom, consequently, should be even greater than the record total at the 1927 Fair.

"The Fair which was instituted in a small way in 1915," Mr. Samuel concludes, "has grown from year to year and has now established itself. With the continued support of the great commercial organisations, it will become increasingly valuable in helping the sale of British goods."

ALL-GAS HOUSES FOR MODEL ESTATES.

Following the inauguration of a scheme to provide a smokeless village for Hendon —an outlying suburb of North London— several similar projects aiming at the total elimination of domestic smoke-producing apparatus have been launched in various parts of the Metropolitan area.

Two hundred acres in the Wembley Park district are now being laid out as a new estate on model town-planning lines. The houses, some of which are already under construction, will be provided with a tiled bathroom and scullery and will be equipped with electric lighting, a gas cooker and a gas boiler for a constant hot water supply. To maintain still further the rural aspect of the locality a site of 44 acres will be laid out as a public park.

A new estate which is being erected in Finchley, by private enterprise, will be composed exclusively of all-gas houses. They will be artistically planned with pleasing interiors, one of the features being a beautifully designed fireplace in the reception room. In addition to a gas cooking stove of modern pattern, each house will be provided with a water heater and a gas fire in every bedroom. Gas points will be laid on to every room in the house.

Other smokeless villages have been planned for South Harrow, Middlesex, and Wallington in Surrey.

MELLON INSTITUTE OF RESEARCH.

We have been informed that Dr. Edward R. Weidlein, director of Mellon Institute of Industrial Research of the University of Pittsburgh and president of the American Institute of Chemical Engineers, will spend the coming months of September and October in visits to European educational institutions, research laboratories, and chemical works. While abroad he will also confer with a number of educationists and laboratory directors regarding various problems in industrial research organisation and management. Dr. Weidlein plans to be in England during the period September 14-24 ,where he may be addressed c/o The Old Colony Club, 79, Fore Street, London. His continental trip through Germany, Switzerland, Italy, and France will follow.

CANADIAN SALT PRODUCTION UP 12 PER CENT. IN 1926.

Salt production in Canada continues to increase; the high record of 233,746 tons produced in 1925 was topped by a new high mark of 262,547 tons in 1926 according to final statistics just issued by the Mining, Metallurgical and Chemical Branch of the Dominion Bureau of Statistics at Ottawa. This year's output value was reported at $1,480,149 as compared with $1,410,697 for the 1925 production. The average price for all grades declined somewhat, being $5.68 per ton in the year under review, as against $6.04 in 1925. Ontario's production was 252,345 tons, or 96.1 per cent. of the Canadian total.

PROCEEDINGS AND NOTICES OF SOCIETIES.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

Paper read at the meeting at the Royal Society of Arts, on Tuesday, April 12, 1927 : *Jet and Jetonised Material.* By E. H. CUNNINGHAM CRAIG, B.A., F.R.S.E., F.G.S., M.Inst.P.T.

This investigation is a continuation of, and supplementary to, the writer's former papers upon oil shales, torbanites and cannel coals. The subject is approached from the practical side, *i.e.*, regarding these deposits as retortable material from which oil can be obtained in commercial quantity. The results of many retorting tests made upon a large scale have made it clear that the usual analysis giving percentages of volatile matter, fixed-carbon, ash and water does not necessarily give an adequate criterion from which the value of a given material, or the nature of the oil to be derived from it ,can be determined. This applies particularly to coaly deposits, such as parrots, cannels, torbanites, lignites, and even true coals. The results of the investigation so far have opened up such a wide field for research that it cannot be pretended that anything like complete information has been obtained. However, as some facts of a practical value have come to light, bearing upon retorting problems, it was considered advisable to put before this Institution a brief account of the line of research followed, as well as some of the results and the deductions that appear to follow from them. Much further work along the same or similar lines will be necessary, and the co-operation of a chemist is desirable to enable the full fruits of such an experimental investigation to be gathered.

It has been shown that in the case of torbanites the yield of oil is directly proportional to the percentage or gels in the deposit and the degree of inspissation which those gels have suffered. A microscopic

study of a torbanite, therefore, which enables the percentage of gels to be measured, and their stage of deterioration noted, gives sufficient data to predict with reasonable accuracy the yield of oil in gallons per ton by a known retorting process, and the nature of the oil, whether light and mobile or heavy and waxy.

The term "jetonised," so far as I have been able to ascertain, means that the vegetable shape is retained, though no doubt somewhat flattened by pressure, but not the vegetable structures.

The present investigation was commenced with the view of studying this jetonised condition, of ascertaining whether it is a definite stage in the formation of coal, and what is its value or significance in connection with retorting problems.

The first material to be examined was naturally the type mineral, jet. This substance is very well known, but there seems to have been very little research work done upon it. It occurs included in or associated with lignitic beds, and in some cases can be proved to have uever been subjected to very high pressures. It has a hackly or subconchoidal fracture, a bright lustre, and appears to be almost perfectly homogeneous. The specific gravity is low, 1.17—1.230. All jet that the writer has been able to obtain is of Jurassic or Cretaceous age. Somewhat similar material of Tertiary age is known, but is not considered as true jet. It is sometimes described as bituminous, but on what grounds seems to be doubtful. It does not melt when heated, nor is it soluble to any appreciable extent in solvents for bitumen. It burns easily and intumesces very slightly while burning. Extracted with boiling carbon disulphide, it loses weight to the extent of only 4.4 per cent., and the larger proportion of this is probably water. This does not indicate a bituminous nature.

Examined under the microscope, it is seen that, contrary to what seems to have been the general belief, vegetable structures have not been obliterated.

Figures (shewn by the author) prove conclusively what jet has been originally—it was wood from the heart of a tree trunk, branch or root. The colour under the microscope varies, according to the thickness of the slide, from a bright yellow to a bright red brown, very similar to the colours of a rich oil shale.

The point to be observed is that jet is in much the same physical state as we see in many lignites; it has been wood, but has undergone no doubt various chemical changes ,so much so that it appears at first sight to be homogeneous, has lost its woody fracture, and is capable of taking a very high polish. There are indications that it may have been plastic at some stage.

Treated in the Struben still, it is found to contain 8 per cent. of water, 3 per cent. of which comes off at just above 100° C., while the remaining 5 per cent. is distilled over at temperatures between 160° and 250° C. Nineteen per cent. of the weight of the original material comes off as a light oil (.792 sp. gr.) no doubt containing acids and other impurities. This oil is slightly sulphurous. This distillate comes off at temperatures below 300° C. In addition to this heavy waxy oils appear, but these chiefly come over at temperatures between 300° and 320° C. The total yield of oil and waxes, apart from water, is at the rate of 57.8 gallons per ton. This is a very remarkable result, and indicates that the material is obviously much changed from its original condition. In fact the jetonised condition, if we can recognise it as a definite condition, is seen to be of importance from the point of view of retorting for the extraction of oils and waxes. The original wood has lost water and presumably also oxygen in the form of carbon dioxide. It must have a fairly low carbon-hydrogen ratio, judging from the quantity and quality of the oil produced. In fact it shows a marked advance from the wood stage toward the oil producing stage, that is, oil poducing by what has been called pyrogenesis.

To learn something more about the jetonised condition, and more especially to ascertain whether it can be recognised as a definite stage, a few specimens have been selected from a very large number of lignitic and canneloid deposits, and subjected to special examination and testing.

The first is a lignite of Eocene age from Sumatra. It is a bright clean lignite of canneloid appearance with a subconchoidal fracture, black in colour, but occasionally with an iridescent bloom. Examined under the microscope it appears practically homogeneous, of a rich red-brown colour. It does not show vegetable structures, and very little trace of bedding or lamination, and therefore the deposit has apparently reached a more advanced stage than jet.

The next material to be examined was a lignitic coal from Kyune Canyon, Colorado, of Green River age (Eocene-Cretaceous). This deposit is well laminated, with a hackly fracture. It is quite black, and in fact appears to be a true coal. Cut for the

microspcope, it appears of a deep re-brown colour, slightly darker than the Sumatra lignite. Lamination is well marked, but there are no identifiable vegetable structures, though faint streaks and ill defined lenticles of slightly lighter or darker tints indicate that the deposit has been built up of masses of fine vegetable debris.

URANIUM—SOME RADIO-ACTIVE PROPERTIES.

By T. P. WAITES.

It is well known that uranium possesses radio-activity, and the properties of uranium which I purpose touching on are possibly also well known, but I will risk giving them.

(1) If any common stone be rubbed by a piece of uranium—say quartz, banket, shale, etc.—a thin film of uranium oxide is left on the stone rubbed, and the stone thus acquires a spurious permanent radio-activity. The softer varieties of uranium, such as pitchblende, curite, gummite, etc., are the best for this purpose.

(2) If pitchblende, curite, soddite, betafite, or other varieties of uranium be placed in contact, simply, with any common stone, a spurious radio-activity is acquired by such stone through contact. This false radio-activity, is, however, ephemeral only; it vanishes about as quickly as it is acquired.

Years back, I experimented on these lines, and found the work extremtly interesting. It is interesting from an academic point of view, but this academic interest may, if occasion rise, prove to be of practical utility also.—*Journal of the Chemical, Metallurgical and Mining Society of South Africa.*

BIO-CHEMICAL ASPECTS OF THE NATURE OF LIFE.

On March 16, before a joint meeting with the Society of Chemical Industry, Prof. J. C. Drummond gave a lecture on "Bio-chemical Aspects of the Nature of Life," at the University, Prof. W. H. Roberts presiding.

Professor Drummond pointed out that the differentiation between systems which might be regarded as living and non-living had occupied the minds of thinkers from the very earliest times. "Animism," which was founded in the Middle Ages, had survived in the various vitalistic theories current at the beginning of the last century. These theories had been shaken by the discoveries of Wöhler, which, together with the work of such chemists as Moore and Baly, had taught us something of the transition from the inorganic to the organic; there had also been great extensions in the study of the evolutionary processes of plants and animals.

Further light on the subject had been provided by the study of ultra-microscopic viruses and the bacteriophages of d'Herelle.

The phenomena of life could be studied under such headings as growth, assimilation, respiration, reproduction and movement, all of which represented complex energy changes. Warburg had shown that the process of respiration was to a large extent controlled in the cell by the presence of iron, which element seemed to occupy an important role. In all cells there was an iron-containing pigment known as cytochrome, which was related to the blood pigments known as the hæmoglobins.

Even in the phenomenon of reproduction it had been found that the processes of fertilisation and cell division could be controlled in the laboratory by physical and biochemical methods.

Dakin and his colleagues had emphasised the importance of the arrangement of amino-acids in the protein molecule as affecting the biological specificity of various proteins.

The lecture was greatly appreciated, and Prof. Drummond was accorded a hearty vote of thanks.—*Journal of the Institute of Chemistry.*

NOTICES OF BOOKS.

THE VITAMINS.

We have received copies of several studies on the vitamins and other constituents of the rind of citrus fruits, by Stanley Gordon Wilmot and Frank Wakes (Biochemical Laboratory, Cambridge, and the University of Liverpool).

The authors shew :—

1. Grape-fruit rind contains considerable amounts of vitamin B, but practically no vitamin A. The content of vitamin C has not yet been investigated.

2. Naringin, the specific glucoside of the grape-fruit, was found present in the rind and in alcoholic extracts of it.

3. Data are presented on the reaction and content of oxidising enzymes as compared with the vitamin A content in the three *Citrus* fruits.

In August last year the authors submitted an interesting paper on the subject to the British Pharmaceutical Conference at Leicester, of which the following is a brief summary :—

SUMMARY AND CONCLUSIONS.

Preliminary experiments reported to the previous meeting of this Conference having shown that Cortex Limonis, B.P., contains considerable amounts of vitamin, the investigation has since been carried further with a view to identifying the individual vitamins. The difficult digestibility of the peel was overcome by preparing alcoholic extracts of the same strength as Tr. Limonis Fortis, B.P.C., the tinctures thus obtained being analysed as the commercial tincture. These tinctures prepared under known conditions were then quantitatively administered to rats on diets deficient in various factors, and to guinea-pigs on diet deficient in " C " vitamin. The results of these feeding experiments showed that Tr. Limonis Fort, B.P.C., contains very little " A " or " C " vitamin, but is a potent source of " B " vitamin ,containing almost as much as does yeast, and having the advantage over the latter in that it is practically free from nitrogeneous derivatives. Results obtained by other workers on the " B " vitamin in the albedo of the orange indicate that in the citrus fruits the " B " vitamin is concentrated in the flavedo, and further emphasis is thus laid on the point advanced in our previous paper that in the manufacture of official preparations of lemon-peel as little of the albedo as possible should be taken. The fact that the peel of lemon and other citrus fruits contains large quantities of " B " vitamin, but practically no " C " vitamin, whereas the juice of the same fruits contain very little " B " vitamin, but large quantities of " C " vitamin, raises interesting questions concerning the origin of these vitamins. If the vitamins are synthesised in the flavedo by the action of sunlight, as was suggested in our last paper, it is difficult to explain the absence of " C " from the peel, unless two points can be established : (1) That there is a marked difference in conditions affecting transfusion between the peel and the juice; (2) that the proportions of vitamins in the peel and in the juice vary according to the degree of maturity of the fruit.

THE SWEET POTATO WEEVIL.

From the Government Printing Office, Pretoria, we have received Bulletin 14, giving a full description of the above and its injurious effects to the sweet potato, by C. P. Van der Merwe, Government Entymologist at Durban, Natal.

Also reprint of a lecture on Farmyard Manure, by J. J. Theron, B.A., Ph.D., Lecturer in Chemistry, Potchefstroom School of Agriculture.

This is an important subject for the farmer who has in his various domestic animals producers of cheap, valuable fertilisers, which add materially to the productiveness of the soil. The author gives the following table shewing the quantity of manure, urine included, which the various farm animals produce per 1,000 lbs. live weight per year :—

Animal	Tons of manure per year.	Humus-producing material.	Nitrogen.	Potash.	Phosphate.
Horse ...	8	4,600	130	120	50
Ox	13	4,200	140	120	40
Sheep ...	7	4,500	140	130	60
Pig	15	4,500	120	130	60
Fowl ...	5	4,500	130	100	80

FORTY-NINTH REPORT OF THE CONNECTICUT AGRICULTURAL EXPERIMENTAL STATION, NEW HAVEN, CONN. (1925).

The present volume contains a mass of very varied, interesting and useful information ,notably for all connected with or interested in agriculture and the allied industries. The volume extends to over 1,000 pages, and there are numerous plates and other illustations of many of the pests which take such a heavy toll of the product of man's labour. It might be stated that the Connecticut Agriculture Experimental Station was the first institution of the kind in the United States, and its founders and early officials proved worthy pioneers to whom all connected with agricultural interests owe a deep debt of gratitude. The present volume gives the photos and brief sketches of several of these pioneers, among whom the name of Prof. Samuel William Johnson occupies an honoured place, as he began his crusade on behalf of agriculture in 1855 and for many years almost single-handed write and spoke in advocacy of an agricultural station, and had the pleasure of seeing his efforts ultimately crowned with success. It might be added that the semicentential of this station was celebrated with due solemnity in 1925.

Chemical Reviews.

Vol. IV., No. 1 of *Chemical Reviews* has just been received. It contains three articles of rather wide interest—" Colloid Dynamics," by V. Cofman; " Recent Advances in the Determination of the Structure of Proteins," by E. Klarmann; and " Phosgene," by G. M. Dyson.

Mr. Cofman explains what a colloid is. The original definition endowed colloids with negative characteristics only; they are not crystalline, do not diffuse through membranes, do not exert osmoic pressure, and do not affect the vapour pressure or the freezing point of water. These statements are only partly true; many crystalline substances have been changed into the colloidal condition; the vapour pressure and freeziug point of gels differ greatly from those of their liquid and the swelling pressure is not distinguishable from the osmotic pressure. The size of particles has been used by Zsigmondy and others as a criterion of colloidality. On this view, colloid systems contain particles much larger than molecules yet below the limits of microscopic vision. It is now realised that colloids are not strictly chemical compounds, their composition varies continuously with changes in physical conditions. Mr. Cofman goes on to discuss the colloid variables, deduce adsorption equations, and he ventures a correlation of colloidal processes with ordinary phenomena. As with the other contributions there is an excellent bibliography.

Mr. Klarmann's review of recent work on the elucidation of the structure of proteins is an important contribution to the subject. Research into the structure of the proteins is in a state of flux and it is impossible at present time to accept unconditionally any of the current theories. Nevertheless, this compilation is not without value at the present juncture.

In his article on Phosgene, Mr. G. M. Dyson deals exhaustively with its history, modes of preparation, and properties, including its reactions with inorganic elements and compounds and with organic bodies. There is also a brief section summarising its physiological action.

Chemical Reviews is an American publication; the annual subscription (4 numbers) is 23s. 6d., and the English agents are Messrs. Ballière, Tindall and Cox, Henrietta Street, W.C.2.

Leçons de Chimie Physique. Par P. Maurice Vèzes, Professeur de Chimie a l'Université de Bordeaux. Avec un Preface de M. G. Urbain (Professeur a la Sorbonne). Pp. X + 546. Paper covers, price 50 frs. Paris : Librairie Vinbert, Boulevard Saint Germain 63.

This is an important work, by an eminent author of mature experience, written in refined French, which can be read with pleasure alike by British students and scientific men of more mature growth. It merits a wide reading public.

Atoms and Molecules. By K. M. Craven, B.Sc. (London), F.I.C. Pp. VIII + 142. Cloth, price 7s. net. London : Blackie & Son, Ltd., 50, Old Bailey, and at Glasgow.

The present is a separate issue of Part I. and Chapter X of the author's work, " The Foundations of Chemical Theory." There is contained in the 142 pages a large amount of very useful information in a handy form, and will prove serviceable to the student, who has at hand in a compact form just the information to help him in his preparatory studies.

Titanium, with Special Reference to the Analysis of Titaniferous Substances. By William M. Thornton, Jr., Assistant in Chemistry in the Johns Hopkins University. Pp. 262. Cloth. New York : The Chemical Catalog Coy., 419 Fourth Avenue at 29th Street, U.S.A.

This is one of the excellent monograph series prepared under the auspices of the American Chemical Society, and printed by the well known Catalog Company. One characteristic of these volumes is the complete manner in which each subject is treated.

The Making of a Chemical. By E. J. Lewis, M.A., B.Sc., and G. King, M.Sc., F.I.C. Pp. 288. Price 12s. 6d. net. London : Ernest Benn, Ltd., 154, Fleet Street, E.C.

This book is clearly the result of chemistry in practice as well as in theory. Among other things, he deals with precision apparatus, corrosive materials, and dangerous processes ;it proffers much sound advice on testing and obtaining acquaintance in general with devices that are used for the first time besides describing from the user's point of view the various alternative materials or methods normally available in works practice. By clear explanations, by warnings against the common errors and possible

causes of failure, and by numberless suggestions all based on wide and practical experience, the authors place at the disposal of works chemists just that knowledge which it takes years of experience for any individual to acquire.

Metallurgy: a General Treatise for the Use of Students in Engineering. Pp. XII + 434. By HENRY WYSOR, B.S., Metallurgical Engineer for the Bethlehem Steel Company, formerly Professor of Metallurgy. Third Edition. The Chemical Publishing Coy., Easton, Pa., U.S.A.

The large number of professional engineers and also the much larger number of scientists interested in the subject will find this treatise interesting and instructive. There are many illustrations which materially enhance the value of the work.

Scientific Work of the Late Spencer Pickering, F.R.S. By T. M. LOWRY, F.R.S., AND SIR JOHN RUSSELL, F.R.S. Pp 248. Printed for the Royal Society, and published by Harrison and Sons, Ltd., 44-47, St. Martin's Lane, London, W.C.2. Price 4s.

Mr. Pickering's work on behalf of science generally and agricultural science in particular is well-known, some of his contributions appeared in our own columns, as no doubt old readers will recall, and it is well that a volume has been written so that a compact account of his life work will be preserved for future generations.

The Rayon Industry. By M. H. AVRAM, B.Sc., M.E. A work which correlates the various factors connected with the artificial silk industry, with 171 illustrations. Pp. 622. Price 42s. net. London: Constable & Coy., Ltd., 10-12, Orange Street, London, W.C.2., and D. Van Nostrand Coy., Inc., New York, U.S.A.

The artificial silk industry has become so important in recent years that an authoritative and exhaustive work of this kind was much needed. Full, authoritative, and up-to-date, are applicable to this book, which will be read with advantage, not only by thousands connected with the industry, but by many who are astonished by its rapid development as noted in the public Press from time to time. Some of the illustrations, notably those supplied by the great company of Courtauld and Co., Ltd. (the largest and most successful firm engaged in the enterprise), are very beautiful and give one an idea of the progress made in artificial silk manufacture during the last few

South African Journal of Science, comprising the Report of the South African Association for the Advance of Science for 1926. Pp. 1,150 and hundreds of illustrations. Price 35s. net.

It would be futile in a short space to attempt anything like an adequate review of this ponderous volume.

The Great Earthquake of 1923 in Japan. Compiled by the Bureau of Social Affairs, Home Office, Japan; with 100 plates and 8 illustrations in the text, and 11 companion maps and 7 diagrams in a separate volume. Foolscap 4to, Cloth bound, 641 pages. 2 Volumes: Text and Companion Maps. Price, 22.00. Postage (inland) 45 sen; (abroad, freight extra). Maruzen Co., Ltd., 14-16, Nihombashi-ku Tori-3 chome, Tokyo, Japan.

The present English version has been based upon " A History of the Great Earthquake," in Japanese, compiled by the Government, and is issued in order to inform the world at large of what the people suffered from a terrible outburst of the potential forces which may at any time overwhelm a nation, and also as a slight token of gratitude to the millions all over the world for the generous sympathy shown to the nation on that tragic occasion.

PLANT CHEMISTRY.

At a meeting of the Manchester Section, Institute of Chemistry, held on March 7, at which Mr. S. E. Melling presided, Prof. E. C. C. Baly delivered a lecture entitled " Plant Chemistry."

Prof. Baly said that probably the one reaction in chemistry which was more interesting than any other was the one by means of which a living plant succeeded in converting carbonic acid or carbon dioxide and water into carbohydrates, including, of course, the simultaneous reactions, whereby materials of the nature of proteins and similar substances were produced. The reaction was interesting because it was the fundamental reaction at the basis of all life. If that reaction did not take place, neither he nor anyone else in the room would be there, because they would not be living. That was why, in spite of all the polarity theories of chemistry which were so fascinating and interesting, there was a fundamental reaction underlying them all which deserved some attention. But, frankly, the problem had proved to be an extremely difficult one. It had been well known for many years, starting originally from the work of von Baeyer, that the process which

was one of extraordinay mystery, and, at one time, something practically magical as well as mysterious had been applied to it in the term *vis vitalis* or " the force of life." It was felt that there was something which differentiated the chemistry of the living organism from the chemistry of inert material.

In 1921, Professors Heilbron and Barker, and Prof. Baly, himself, published a preliminary paper in which they claimed to have obtained ordinary formaldehyde by the action of light upon carbon dioxide in water. This claim was considered by many people as a distinct contribution to the subject of the photosynthesis which took place in the leaves of plants. The pioneers in this particular experimental field were Prof. Moore and Mr. Webster, who had investigated the possibilities of the conversion of carbonic acid into formaldehyde. They found that when solutions of carbonic acid in water were exposed to ultra-violet light, nothing happened; that was to say, they were unable to detect the formation of formaldehyde, but they did find that in the presence of colloidal ferric hydroxide small quantities of formaldehyde were produced. Prof. Baly said he and his fellow workers differed somewhat from that conclusion because they found that, if water through which a stream of carbon dioxide was passed were exposed to ultra-violet light, there was afterwards very definite evidence of the formation of formaldehyde. Moore and Webster showed that formaldehyde, on exposure to ultra-violet light, was converted into substances which showed some of the reactions of ordinary hexose sugars. Subseqnently, said Prof. Baly, there had been put forward the idea that formation of carbohydrates in the living leaf took place in two stages, the first stage being the formation of ordinary formaldehyde, and the second stage being the subsequent conversion of the formaldehyde, by polymerisation under the action of light, into sugar. As a matter of fact, when this proposition was examined from the physico-chemical point of view it was found to be erroneous. According to modern views of chemistry, every single reaction required that the reacting molecules must be activated by the supply of a certain amount of energy before they underwent any reaction whatsoever. The great mystery of the living leaf was that, in spite of the fact that a very large number of gram-calories had to be absorbed to bring about the reaction, yet the plant managed to effect it by means of visible light, and indeed, as far as one could ascertain, by light which lay within the yellow region of the spectrum. There was a photo-chemical reaction on the surface of the leaf, and it was believed that the large total quantity of energy necessary to activate the carbonic acid was supplied by visible light. Photosynthesis took place in those cells which contained chloroplasts. There was strong evidence that the phenomenon of photo synthesis of the plant was due to surface absorption. There was also a fatigue effect to be considered. If the light was too strong, the plant ceased to work, though it became active again after being placed in the dark for a couple of hours. With too much light the functioning power of the chlorophyll was arrested.

Prof. Robinson proposed and Dr. E. Ardern seconded, that a vote of thanks be accorded to Prof. Baly for his extremely interesting lecture; this was carried by acclamation.

A discussion then ensued in which Prof. Robinson Dr. E. Ardern and Messrs. E. Thomas, Short, Manley and Hannah took part.

Prof. Baly, in replying to the discussion, said that a systematic examination was being conducted in regard to sugar syrups, which were formed by the action of light and concentrated formaldehyde.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

19,514.—Anderson, I. B.—Production of dyestuffs. July 22nd.

19,066, 19,067.—I. G. Farbenindustrie Akt.-Ges.—Manufacture of dyestuffs. July 18th.

19,071.—Rath, C.—Production of nitropyridine arsinic acids. July 18th.

19,178.—Soc. L'air Liquide, Soc. Anon. pour l'Etude et l'Exploitations des Procedes G. Claude.—Processes for carrying out exothermic catalytic chemical reactions. July 18th.

Specifications Published.

250,909.—I. G. Farbenindustrie Akt.-Ges. —Process for the production of azo-dyestuffs and lakes insoluble in water.

269,931.—Gaillard, A.—Process for treating superphosphates.

274,197.—Appleby, M. P., and Carter, C.—Manufacture and production of solid sodium hypochlorite preparations.

Abstracts Published

272,058.—Lead Carbonate.—Smith, S. C., 701, Salisbury House, London Wall, London.

In the production of lead carbonate by passing carbon dioxide into a suspension of lead sulphate in a solution of ammonia, the carbon dioxide is passed into the suspension at such a rate that it passes into the form of lead carbonate as nearly as possible *pari passu* with its introduction into the suspension, and the presence of carbon dioxide in the solution is avoided as far as possible. By this means the lead carbonate obtained is substantially free of lead sulphate. Specification 239,257 is referred to.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

MATRONAX BRAND.

479,029.—Chemical substances prepared for use in medicine and pharmacy, but not including medicated soap and not including any goods of a like kind to medicated soap.—H. R. Napp, Limited, 3 & 4, Clement's Inn, Kingsway, London, W.C.2. July 27th.

HARPIC.

481,913.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—Harpic Manufacturing Company, Limited, 2 to 14, Staple Street, London, S.E.1. July 27th.

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THE CHEMICAL NEWS

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OBSERVATIONS ON SOLUBLE META-TUNGSTATES.

By EDGAR F. SMITH.

Upon examining the literature relating to these highly interesting bodies certain discrepancies crop out. Thus, Carl Scheibler, whose studies on tungstates in general have been long regarded as authoritative and classic, said in his thesis, *De Wolframiatibus* (1861), that lead meta-tungstate, for instance, was a white insoluble precipitate, while in the *Jour. für prakt. Chemie*, LXXXIII., 319 (1861), he described it as a white flocculent salt, soluble in nitric acid, and in both places assigned it the formula $PbO.4WO_3.5H_2O$. His analysis, however, was restricted to a water dedermination equal to 7.85 per cent. No mention was made of the lead oxide and tungsten trioxide content. Curiously enough Scheibler adopted the same course with nearly all the meta-tungstates analysed by him, although with silver meta-tungstate he did make a direct determination of all the components, while with the cerium salt he was satisfied with a direct determination of the tungsten trioxide and that of the water. True, with the barium salt he gave a complete and elaborate analytical exhibition, which was quite natural as this particular salt was made by him the basis of a re-determination of the atomic weight of tungsten (*Jour. prakt. chem.*, LXXXIII, (1861), p. 324).

It may not be out of place to add that in the preparation of lead meta-tungstate Scheibler recommended introducing lead acetate into aqueous solutions of meta-tungstic acid, or into those of its salts.

Turning to Wilhelm Lotz' thesis (*Chemische Untersuchungen über die Wolframsauren Salze*, p. 39, 1854), one reads that a white crystalline precipitate was produced on adding a solution of lead acetate or nitrate to a solution of ammonium meta-tungstate. On using concentrated solutions the liquid, on cooling, solidified to a crystal magma, soluble in much water, and from this solution, upon spontaneous evaporation, there separated long, thin, silky needles, having *probably* the formula $PbO.4WO_3.6H_2O$, because 'a sample, obtained with lead nitrate as precipitant and purified by recrystallisation, gave 70.98 per cent. WO_3, 19.84 per cent. PbO and 9.18 per cent. H_2O, instead of 73.71 per cent. WO_3, 17.72 per cent. PbO and 8.57 per cent H_2O, as required by the suggested formula. Lotz explained the excessive percentages of lead oxide and of water as due, very likely, to an admixture of lead nitrate. He was silent about the deficit in tungsten trioxide (*Annalen der Chemie und Pharmacie*, XCI, (1854) p. 74).

Following the literature in its natural development one next discovers Vincent Forcher (*Sitzungsbericht Wiener Akademie* XLIV, (1862), p. 164; *Jour. prakt. Chemie*, LXXXVI, (1862), p. 244), asserting that his study of meta-tungstic acid and its derivatives was concluded long before the appearance of Scheibler's exhaustive communication, but illness delayed its earlier publication. He related that on mingling concentrated aqueous solutions of sodium meta-tungstate and lead nitrate there resulted a crystalline mass, which after filtration, was pressed to remove adherent mother liquor, and then dissolved in much hot water and the resultant liquid concen-

trated by slow evaporation, when there separated out long, beautigul, silky crystals, much matted together. These Forcher considered to be lead meta-tungstate. He did not analyse them but, after purification by recrystallisation from hot water, he employed them in getting free meta-tungstic acid.

Having an abundance of sodium and ammonium meta-tungstates at command, the writer sought to repeat Fourcher's experiments, whereupon exceedingly beautiful crystals, supposedly lead meta-tungstate, were obtained, but at every effort to dissolve them for purification purposes there invariably appeared a *white residue*, never once mentioned by Forcher. It appeared constantly in the writer's work. He had observed Forcher's statement that the first crystalline mass was soluble in a large volume of hot water. It will be recalled that Lotz, too, on describing the "crystal magma" thought by him to be the normal lead meta-tungstate pronounced it soluble in large volumes of water, but he did not specify whether it was hot or cold water. The aqueous solution from the "white residue" gave needles, the analysis of which did not indicate them to be the normal lead meta-tungstate. Casting about, in more recent literature, for light, the writer next encountered statements of Rosenheim (*Z. für anorg. Chem.* LXIX, 251) to the effect that difficultly soluble lead meta-tungstate mentioned frequently in the literature (in most instances without analysis) could not be prepared by transposition of alkali meta-tungstates and soluble metaltic salts, or by neutralisation of free meta-tungstic acid with lead oxide or carbonate, but that the products were precipitates of varying composition, the individuality of which had no proof, and in fact that the "silky needles" of Lotz and those of Vincent Forcher, were not, as suspected, normal lead meta-tungstate admixed with lead nitrate, but, in reality, were double salts of meta-tungstates and nitrates—a class of compounds of which both an ammonium salt (*Ann. Chim. phys.* (3) LXIX, 1868, p. 61 Marignac) and a barium salt (*Ann. Chim. phys.* (6) XXII (1891) p. 198) had been prepared. Further Rosenheim maintained that normal lead meta-tungstate—$PbO._4WO_3.Aq$ did not exist. The product of the interaction of lead acetate or nitrate and sodium meta-tungstate (even on using calculated amounts of the salts) dissolved with difficulty in water and gave results approximating the formula

$$PbO.4WO_3.PbO.N_2O_5.10H_2O$$

Calculated.			Obtained by Rosenheim.		
Pb	—	24.91	Pb	—24.67	—24.61
WO_4	—	56.80	WO_4	—56.93	—56.89
NO_3	—	7.46	—	—	—
H_2O	-	10.83	H_2O	—10.83	—11.18

Perhaps this double salt may have been really a complex, *e.g.*, lead nitrato-tungstate — $2PbO.N_2O_5.4WO_3.10H_2O$, corresponding to the complex vanado- and phospho-tungstates in all of which the tungstic acid is the meta-acid or its residuum, and this complex in turn was hydrolyzed, giving rise to the white residue to which frequent reference has been made.

However, the student who has read the preceding paragraphs will feel himself embarrased and at a loss on considering the existence of normal lead meta-tungstate when an emphatic declaration places this salt without the pale of regular derivatives of meta-tungstic acid. He may vigorously oppose the idea for the reaction-formation of the salt is so simple—it is not in the slightest degree involved—and then, too, little deportments of the suspected body continue to keep him alive to the possibility of there being an actual salt corresponding to that simple formula—

$$PbO.4WO_3.Aq.$$

Such was the impression of the writer and accordingly he continued to bring together concentrated solutions of sodium meta-tungstate and lead nitrate (these salts in equivalent quantities). Upon stirring the mixture there followed in a few minutes a complete solidification so that the stirring rod was maintained in a perpendicular position by the crystalline mass. The latter was filtered out and pressed between sheets of paper after the recommendation of Forcher; and, further the dry mass was projected into a large volume of hot water. The quantity of sodium meta-tungstate, of lead nitrate and the volume and temperature of the water employed were always known. Thus, the reaction-product of 50 grams of sodium meta-tungstate and their equivalent of lead nitrate was introduced into two and one-half litres of water at 80° C. temperature. After contact of from two to three hours, the insoluble material was filtered out, air dried and preserved in weighing bottles. The filtrates from the white insoluble portions were reduced in volume on the water bath at a temperature

not exceeding 70° C. During the evaporation or in the course of a night the insoluble powder continued to separate. Finally, a liquid much contracted in volume remained clear for several days and then there separated from it brilliant needles soluble with difficulty; these analysed for the salt described by Rosenheim—the salt which represented a probable complex :

$$2PbO.N_2O_5.4WO_3.10H_2O.$$

In the liquor from them upon evaporation almost to dryness silky, white needles separated. At once the thought arose that these were the coveted normal lead meta-tungstate. On analysis, however, of many such samples carried out through months the results were wholly unsatisfactory, so that often the writer found himself harbouring the thought that probably normal lead meta-tungstate did not exist. Yet, the recollection of all that had been submitted in its favour by Lotz, Scheibler and Forcher clung to his memory. They had not intimated anything in regard to an insoluble white powder in the solution of their supposed lead meta-tungstate, nor had they come upon the salt of Rosenheim. The latter salt, however, had been definitely seen and analysed by the writer, so that he was disposed to view the white powder as a mixture such as Rosenheim believed could not be disentangled and particularised as definite bodies. Yet, there was before the writer the fact, *viz.*, that no matter from what experiments he procured the white insoluble powder it showed in every instance a definite and concordant water percentage. The next step was accordingly to execute a complete analysis of the powder. It was done and gave as result :—

63.38	per cent.	WO_3
31.00	,, ,,	PbO
5.74	,, ,,	H_2O

Similar analyses of other samples concorded well with these figures which approximated the formula :

$$PbO.2WO_3.2\ 1/2H_2O.$$

63.30	per cent.	WO_3
31.46	,, ,,	PbO
5.14	,, ,,	H_2O
99.90		

Little comment is necessary. The product is unusual. It suffices to know that the ratio between the oxides PbO and WO_3 assigns it to the class of di-tungstates although these, as a rule, are soluble in water. But it is quite surely a hydrolytic product. From whence did it come? From Rosenheim's nitrato-tungstate or from a genuine normal lead meta-tungstate, or from contaminating bodies in the latter?

Casting about for other means of reaching pure normal lead meta-tungstate there came to mind the recollection that Scheibler (*Jour. prakt. Chem.* LXXXIII (1861), p. 307) noted " it was very difficult to get perfectly pure sodium meta-tungstate," which was the starting-out compound in the present work. It had never been tested for its purity. It was thought sufficient that it had been prepared with the customary care and had been frequently recrystallised from water. But now, where so much was involved, an examination of the sodium salt at hand was made. It proved, despite its excellent appearance, to be astonishingly impure! The ammonium meta-tungstate used at times was little better.

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(*To be Concluded Next Week.*)

SOME ASPECTS OF THE CHEMICAL INDUSTRY.

By W. J. U. Woolcock, C.B.E.

(*Abstract of paper read before the Royal Society of Arts, December* 15, 1926.)

Chemical industry in the 20th century is distinguished by very different features from those which characterised it in its earlier periods. It has an infinitely wider significance. It aims, with reasonable probability of ultimate success, at achievements which not very many years ago would have been regarded as being as unlikely of fulfilment as was the old alchemist's dream. Armed with the accumulated experience and results of seventy years of organised research, the chemist to-day is vastly nearer, and perhaps it may be said, within measurable distance of, the ideal scheme of organic synthesis. That is to say, the general building up of organic chemical compounds from the elements by affecting their union under conditions favourable to the production of one or another compound at will. How long it will be before such a scheme becomes an accomplished fact cannot be estimated, but the enormous advances recently made in

the realm of gaseous combination under high temperatures and pressures in the presence of catalysts would appear to indicate that the idea is no longer the wild dream of the theorist, but that it is to-day distinctly a practical possibility. On the basis of such research work, the industry has progressively increased its contribution not only to the comfort and well being of the peoples of the world, but to their very existence.

Modern chemical industry has done a great deal towards ekeing out supplies of naturally occurring products. Nature's resources are vast, but not unlimited, and this fact has provided much of the motive power behind some of the most brilliant industrial chemical achievements of the present generation. Take the case of nitrogenous fertilisers. The rapidly increasing population of the civilised world calls for increased agricultural development, and the maximum yields of crops from any given area under cultivation. Wheat, the most important of all vegetable foodstuffs, requires nitrogen in a readily assimilable form. The nitrogenous saline deposits in the world are neither inexhaustible, nor are they widely distributed. These facts gave a tremendous impetus to the synthetic manufacture of ammonia by the Haber process, for, in the form of sulphate, ammonia is one of the most valuable fertilisers. At the present time vast quantities of ammonia are being produced synthetically by this and similar processes in different parts of the world.

Not only, however, is chemical industry a vital factor in feeding the human race, but it plays an important part in developing and improving the amenities of civilisation. It is a commonplace to say that it enters into every part of our daily life. Indeed, so universal is its application that it is passed without comment and without notice. Herein lies a danger. I believe it to be possible to bring home to the minds of most people the part which science plays in clothing, therapeutics and medicine, power and locomotion, heating and refrigeration, and so on. To each of these it generously and continuously contributes. The natural fibres used in the production of fabrics for clothing and furnishings are supplemented by artificial silks. The production of heat and power, which are of the greatest importance to every industry and to mechanical locomotion, are the objectives of the very active research which has for some time been engaging the attention of industrial and academic chemists working on the low-temperature carbonisation and the hydrogenation of coal, and the synthesis of alcohols and other internal combustion fuels by the catalytic reaction of carbonaceous gases and hydrogen. At the same time the reverse of heat production, refrigeration, is of paramount importance to a multitude of processes in organic chemical manufactures, and in the liquefaction and separation of gases, as in the Haber process.

Since the discovery, some forty years ago, of the valuable therapeutic properties of antipyrin enormous strides have been made in the manufacture, alongside coal-tar dyestuffs, of pharmaceutical products wherewith to combat the ravages of disease and to alleviate the sufferings of mankind. The chemist has worked hand in hand with the clinician, medical practitoner, and biochemist, and the world to-day reaps the benefit of the labours in this field. Improved narcotics and anæsthetics have robbed manipulative surgery of much of its terror.

It is a truism that a great power for good may also be a great potential evil, and so it is with the agency that has conferred these boons upon us. The same chemical plants which in time of peace minister to man's needs and comforts and physical developments can, in the event of war, be almost instantly diverted to the manufacture of explosives, poison gases, etc., wherewith to destroy life, and it is an ironical commentary upon the progress of science that the same accumulated knowledge which advances the peace-time industry is at once available for, and capable of, furthering the output of these death dealing substances.

Growth of the Chemical Industry.

Up to the middle of the 19th century chemical industry was mainly concerned with the manufacture of "Heavy chemicals"—acids, alkalis, and inorganic salts —and it was not until the discovery of the latent possibilities hidden away in the waste product from the gas works, coal-tar, that serious attention began to be paid to the large scale manufacture of organic chemicals. The year 1856, in which the first aniline dyestuff was prepared by Perkin, marked the beginning of a new era and opened out a vast new field of research, industrial development, and commercial enterprise extending to the utmost limits of civilisation.

The growth of the chemical industry from that time onward was essentially the growth of organic chemistry, built up on

the foundation of research work carried out upon the raw materials obtained from the distillation of coal-tar. The immediate goal of the researchers in this new field was the discovery and manufactnre of colouring matters wherewith to replace the more fugitive natural dyestuffs hitherto in vogue. The history of the dyestuffs industry from its inception right up to the present time is one of brilliant achievement in science, technology and engineering. The conversion of simple tar products such as benzol, phenol, and anthracene into the more complicated substances known as intermediates, and, finally, the latter into highly coloured bodies with powerful tinctorial properties became the pivot around which the remainder of the chemical industry virtually revolved. In its operation it required large quantities of the heavy chemicals—nitric, sulphuric and hydrochloric acids, soda, caustic soda, salt, chlorine, etc.—bringing added prosperity to the existing industries which produced these commodities. Similarly it brought trade to the metallurgical and engineering industries. Coal-tar became a valuable product and its fractional distillation a great industry.

But research is essentially the pursuit of the hoped-for, during which the unexpected frequently happens. It was inevitable that in the course of their researches on dyestuffs the army of investigators should come across new substances which were not dyestuffs, but which possessed valuable uses in other directions. Such substances were often found to occur as by-products in the main manufacturing processes, and their utilisation was of paramount importance to the economic conduct of the latter. This is well illustrated in the example of pharmaceutical products, the manufacture of which has developed to immense proportions alongside, and in conjunction with, that of synthetic dyestuffs.

EXTENSION OF FIELD OF OPERATIONS.

As I have already indicated, the organic chemical industry, which at the present time is to be regarded virtually as synonymous with the dyestuffs and fine chemical industries, was weighted with a very big over-capacity, and as a consequence attention was paid to the exploitation of new fields. Here I pause to emphasise the character of the new developments. It is not necessary to go back to the time of the old alchemists to illustrate the romance of chemical industry. I need only remind you that a century ago such chemical industry as existed was exclusively what we now refer to as heavy chemical manufacture, and the number of products was very limited. From that period we passed to the synthetic organic stage in our development when thousands of new chemicals were produced each in relatively small quantities and very few of them of great industrial importance, although their scientific value may have been great. Now, at the present time, we are experiencing a great change. This generation sees the energies of its chemical industrialists devoted fiercely to the production, in enormous quantities, of synthetic substitutes for products in great demand. Out of the many important offshoots from dyestuffs—pharmaceutical products, films, photographic chemicals, and so on—there is none comparable in its far-reaching significance with the vast field opened out by the comparatively new synthetic operations whereby gaseous products are combined under conditions of high temperature and pressure in the presence of catalytic substances. Of this type of process the classical, and to-day economically the most important, example is the synthetic production of ammonia by the combination of nitrogen and hydrogen, a process which was firmly established before the war on a large scale on the German Rhine.

Quite recently the principle has been extended to the commercial production of methyl and the higher alcohols, at prices which will undoubtedly have a profound effect upon the older wood-distillation processes and a tremendous influence upon those industries in which the alcohols are extensively used. The latest application of high pressure reactions is in connection with the preparation of liquid fuels by the hydrogenation of coal.

SYNTHETIC AMMONIA AND FERTILISERS.

At the outbreak of war in 1914 Germany was the only country producing ammonia synthetically—by the Haber-Bosch process. To-day the factories at Leuna and at Oppau are functioning on a prodigious scale and are being extended, and it is expected that the output of pure nitrogen will exceed 450,000 tons annually. In addition to producing synthetic nitrogenous fertiliser in the form of ammonium sulphate the German chemical combine prosecutes extensive agricultural research to promote the sale of its products. As a result of this systematic research a new form of nitrogenous fertiliser was recently placed on the market under the name of Leuna saltpetre, a double ammonium sulphate nitrate, which is claimed to be superior to the sulphate for certain kinds of crops.

In Great Britain the Synthetic Ammonia and Nitrates plant at Billingham, which is also based upon the Haber principle, is now in regular operation, and it is estimated that its capacity will eventually be 800,000 tons of ammonium sulphate per annum, or slightly less than the present total British output of by-product sulphate.

America has seven important plants working, with a combined output of 70 tons of anhydrous ammonia per day (equivalent to 250 tons of sulphate), which it is expected will be increased to 100 tons per day at the end of the year.

In Switzerland the Ammonia Casale Company, with headquarters at Lugano, has a plant with a capacity of about 135 tons of anhydrous ammonia per day.

Apart from the importance to agriculture of the fixation of nitrogen, the synthetic manufacure of ammonia is of increasingly wide significance to the heavy chemical industry. Take the sulphuric acid industry, which is vitally interested in the tendency of the German and the Billingham concerns to replace the free acid, for converting ammonium into sulphate, by the naturally occurring sulphate of calcium—gypsum. It is quite conceivable that this alternative may eventually be adopted by the gas companies. Again, the development of the manufacture of nitric acid by the catalytic oxidation of ammonia proceeds, and is of special interest in those countries where a lack of cheap supplies of electricity renders the arc process uneconomical. Nitric acid is likely to be in greatly increased demand for the growing artificial silk and nitrocellulose lacquer industries.

Synthetic Methyl Alcohol.

The process recently discovered and now in commercial operation in Germany for the synthetic manufacture of methyl alcohol (Methanol) probably ranks amongst high pressure syntheses second in importance to the Haber ammonia process.

Liquid Fuel From Coal.

In close relationship with the synthesis of methyl alcohol stands the work which is being carried out on the hydrogenation of coal, which has for its object the economic production of motor fuels by the application of the principles associated with the names or Bergius and Fischer. At the moment it is difficult to form any clear idea of the stage of development at which the work carried out in Germany has arrived, but it appears doubtful whether much progress has been made beyond the purely experimental stage.

Artificial Stage.

Propably no branch of chemical industry has shown more rapid progress in recent years than has that of the manufactuts of the fibres known as artificial silk. The rate of development may be judged by comparing the word's output of all varieties for the years 1925 and 1923, the figures being 197 million and 97 million pounds weight respectively. Last year's statistics shew America as the greatest producer, with Great Britain, Italy and Germany closely competing for the second place. Whilst the four varieties of artificial silk: Viscose, Nitro-Cellulose, Cuprammonium, and Cellulose Acetate, still hold the field, Viscose represents by far the bulk of the production.

THE LUMINOUS DISCHARGE THROUGH RARE GASES.

By Richard Whiddington, M.A., D.Sc., F.R.S., Cavendish Professor of Physics, University of Leeds.

(Abstract of paper read before the Royal Institution of Great Britain, April 28, 1926.)

Summary.

When a current from a storage battery is passed through a vacuum tube containing Argon or Neon at low pressures, the discharge presents the usual ordinary appearance of positive column to the eye.

When viewed in a rotating mirror, the luminosity is seen to be regularly intermittent, consisting of brilliant coloured flashes moving quickly down the tube from anode to cathode.

The speed of these flashes is inversely proportional to the pressure of the gas, is determined to some extent by the value of the current, but is not much affected by the applied potential.

When the gas is impure the flashes are non-uniform, sometimes evidenced by a general wavy appearance in the mirror, sometimes by two clearly diffierentiated sets of flashes of differing speeds in two parts of the tube.

Possible theories of this new type of discharge are mentioned, and its relation to the well-known discharge phenomena discussed.

The form and character of the luminous discharge in the ordinary gases under conditions of low pressure and constant potential are quite well known. It will, therefore, be sufficient to pass these facts rapidly

in review as an introductory to the new phenomena in the case of the rare gases.

A long glass tube evacuated to a pressure of 1 mm. of mercury or thereabouts, and furnished with plane electrodes, will, when fed with current from a constant potential of a hundred or so volts, present a characteristic appearance: the most important visible parts, proceeding along the tube away from the cathode, being the cathode dark space in which the luminosity is relatively faint, the negative glow, the Faraday dark space, and then, filling the majority of the tube if it be a long one, the positive column.

The cathode phenomena in this ordinary type of discharge are perhaps the most arresting, and it may not be out of place for our present purpose to notice in passing the explanations and to perform one or two experiments.

The cathode is, of course, the seat of the cathode rays which stream away down the tube, ionising in their course. They are produced at or near the surface of the cathode by the impact of positive ions which originate most plentifully at and beyond the luminous boundary of the dark space. This space is dark because of the very high electric force obtaining there due to the space charge action of these positive ions, which high force prevents the re-combination essential to luminous emission. The dark space edge, therefore, marks the point at which the electric force has fallen to so low a value that the positive ions and the electrons from which they have been forced to part company are not so very rapidly swept past each other. It is a region of high conductivity. That this is the region from which the positive ions bombarding the cathode to produce electrons are drawn may be shown by this experiment.

A specially designed tube is furnished with a movable anode, which, when moved towards the cathode, produces no effect beyond the gradual disappearance of the part of the discharge through which it advances. The milliameter shows the strength of the current is approximately maintained until the anode reaches the edge of the dark space. The current then suddenly stops. If the anode be moved back now, ever so slightly, the current begins to flow once more and luminosity reappears.

In passing, too, an interesting matter may be noted. If the anode is screwed back just to the point at which the discharge may be expected to recommence, but no further, a considerable delay may take place before it appears. If, however, a sample of radium be brought up, the current at once commence to flow, and we see the very thin layer of negative glow proper to the conditions of the tube.

The explanation in all probability is that a stray ion or so is necessary to the initiation of the discharge, and we are perhaps dependent on the natural ionisation produced, maybe by the hard, all-pervading cosmic rays.

With the tube in the condition we chose, there is only a very thin layer of gas containing a comparatively small number of molecules available to this ionising agency. The chance of ionisation is small; we must wait for it. If impatient we can increase the chance enormously by bringing up the stronger ionising agent. The same result, of course, could have been effected by withdrawing the anode a little further.

The important point, however, is that at a given gas pressure the anode and cathode must be more than a certain distance apart or the discharge goes out.

Reverting now to the tube in which the electrodes are a considerable distance apart, it should be pointed out that whereas very close to the cathode the field is determined in large measure by the potential applied, yet as points further and further away are considered the space becomes more and more important, until, when the positive column itself is reached, these spaces take control of the field almost entirely. Closely connected too with this matter of the space charge is the wall charge. This arises because both electrons and positive ions diffuse, the former more readily than the latter, with the result that the walls become negatively charged. There is thus set up a radial component of current which is of some importance in quantitative considerations.

The presence of this wall charge is rather well shown by an experiment in which the cathode is surrounded by a movable glass sheath. When this sheath is moved out over the cathode the pencil of cathode rays, originally broad, is compressed to a far narrower pencil as a result of the action of this negative wall charge.

It is a matter of some interest to notice here that experimenters with the luminous discharge have often found difficulty in maintaining the current perfectly steady. There is always a tendency for intermittency to appear, a regular oscillation often of very high frequency causing a note or hiss, for example, to be apparent in a telephone receiver included in the circuit. Yet

in the striated form of discharge at any rate, viewing the tube in a rotating mirror reveals usually no discontinuities.

When a discharge tube containing a rare gas—argon for example—comes to be examined, new features are at once apparent. When the continuous positive column is viewed in a rotating mirror very obvious variations in luminosity appear.

When no special pains are taken to ensure purity of the gas, the appearance is very irregular, but with argon carefully purified from hydrogen and nitrogen by the usual means, a very beautiful and regular appearance is presented.

This can only be due to a perfectly regular sequence of luminous flashes travelling with approximately uniform speed down the tube from anode to cathode. Viewed directly, the so-called uuiform positive column only is seen; viewed in the mirror its lack of uniformity is immediately obvious.

The inclination of the flashes is a measure of their speed, and by taking instantaneous photographs of the tube in the mirror simultaneously with a small mercury vapour arc fed with alternating current of power high frequency to act as a time-marker, the actual velocity of the flashes can be calculated. The speed varies with the pressure from about 10^3 to 10^6 cms. per second, and hardly depends at all on the potential applied to the tube except in so far as this changes the current.

Very approximately the product of the speed and the pressure is constant, at any rate over ranges not too large.

The spectrum reveals argon lines all along the tube, with the addition of hydrogen lines—strong near the anode—and are weak or absent near the anode.

It is natural to suggest that these flashes (or moving striations) consist of positive ions moving away from the anode; but it is by no means certain that this is the true explanation, and it will be used merely in a tentative manner, while an alternative, and possibly more likely, hypothesis will be introduced at a later stage.

An important point to notice is that so far as experiments with argon up to the present go, the spectrum of the discharge shows no vestige of the Döppler effect when viewed along the tube, whereas the resolving power of the spectroscope was certainly high enough to show the effect had it been present; it is to be supposed then that the motion of the flashes is apparent only, and may be regarded as a state of affairs consequent on the passage of "non-luminous" positive ions through the argon.

Although it has not been found possible to find a quantitative theory of this type of discharge owing to its very complicated and varying forms, it may be worth while here to suggest the manner in which these flashes may be generated and propagated on the view just mentioned.

The space near the anode will contain electrons which at the moment of applying the potential will commence to move up to the anode. Only those electrons originating from a plane further than a certain distance away from the anode will acquire ionising speed at the anode surface. When this sheet of positive ions is formed it commences to move away from the anode as a space charge, which neutralises the field just behind it. The sheet is, therefore, quite thin, and moves away down the tube, its motion being marked by a patch of light apparently moving with it. The sheet may be regarded as acting as a virtual anode, attracting electrons to itself and so keeping up the supply of positive ions.

When it has moved a sufficient distance away a fresh sheet of positive ions is generated in the same way, which again moves off in its turn from the anode; thus a regular sequence of flashes is set up. At some distance away from the anode the motion of a flash is to be regarded as kept up by the repulsion of its successor.

If this be so it might be expected that the potential applied to the electrodes should not affect very much the speed of the flashes. That this is roughly true may be demonstrated by using a tube (containing neon in this case) of the kind used so extensively to-day for advertisement purposes. If an alternating potential of about 800 volts and 50 cycles be applied, the characteristic and apparently uniform positive column is seen. On rotating a mirror slowly the field in the mirror is seen to be cut up by parallel dark lines corresponding to the zero points in the alternating potential. On rotating the mirror more quickly the bright field is seen to be crossed by rather wavy lines clearly of the type we have seen in argon, which reverse their slope at every half cycle. By suitably choosing the speed of our mirror we can select one half of the cycle only, so that attention is concentrated on flashes moving in only one direction down the tube. It is clear when this experiment is performed that, apart from irregularities due to im-

purities in the neon, the inclination of the lines seen in the mirror are about the same; they are all parallel and straight—that is, their speed in the body of the tube are all the same and independent of the applied potential. Near the electrodes, of course, this is not the case.

The speed of the flashes for any one gas appears to depend mainly on two factors—the current and the pressure. Over a limited range of gas pressure it has been found that the product of the pressure and the velocity is approximately constant. This means, of course, as our view of the phenomena would suggest, that at greater gas pressures the flashes move more slowly.

An interesting point is that over a wide range of pressure, and therefore velocity, the flash spacing remains approximately the same; there are at any instant always about the same number of flashes present in the tube (usually three or four only with the tubes ordinarily used.)

If the same charge is associated with every flash, this is what would be expected on our present view if below ionising speed the electrons suffer perfectly elastic impacts. This explanation—qualitative as it is—cannot really be so simple as this, for reasons which will be obvious from what follows.

Multiple excitation easily occurs in the rare gases, and evidence of this effect is not wanting in these discharges. The flashes often double, still retaining the safe velocity.

If it were certain that the current in the tube was carried entirely by the flashes, it would be possible to calculate the charge associated with each flash, and thus the potential in the body of the tube under which the exciting and ionising electrons move. Attempts in this direction give the result that the potential fall involved is about 6 volts. The blue spectrum of argon is present, for which the lowest voltage of excitation so far recorded for high current densities is 19 volts. As the currents used in the present experiments run up to more than an ampere, it is possible that multiple excitation may acount for this very low value. The calculation, however, rests on very doubtful assumptions, and no emphasis can be laid upon it. A very serious difficulty is that while the majority of the luminosity from the tube originates in the flashes, there is a distinct luminous background— whether emitting the same spectrum or not cannot so far be caid; this is almost certainly associated with conductivity, and goes to vitiate any argument of this kind suggested.

When the flashes are followed up to the hot cathode, it is observed that their speed rapidly drops. This is doubtless due to the high conductivity of the gas in this region acting to reduce the electric force there.

The question of these moving flashes is by no means cleared up yet, for there are two very serious experimental objections to the hypothesis just outlined.

The first is, that if there is a considerable convection of gas in the form of ions along the tube, it should certainly be possible to detect a pressure distribution. This has not so far been observed.

The second is, that in the majority of cases so far examined oscillograph determinations of the current show no intermittency, or very little.

These objections would be removed, and most of the phenomena described would be explicable, if it be supposed that the flashes are due to atomic excitation and not ionisation.

The explanation would be somewhat as follows:—Electrons initiated in the cathode region and accelerated along the tube would attain energy sufficient for excitation at some definite plane, producing there a sheet of luminosity.

Just on the anode side of this plane there would thus be brought into existence a sheet of electrons at rest, constituting a space charge. Electrons would move away from this region and accelerate until they in their turn produced further along the tube a second sheet of luminosity, and so the process would be repeated.

On this view there is so far no reason to see why the luminosity should move towards the cathode. There must clearly be some process at work which prepares in advance the atoms on the cathode side of the flash for impending excitation. This may be accomplished by actual diffusion of the excited atoms themselves, by radiation from them, or in some manner combining the two; but since no definite conclusion is possible at present, this bare mention of the speculation may suffice.

We come, in conclusion, to a rather interesting consideration which arises from the possibility of more than one set of flashes of different speeds existing at the same time in the tube. This might occur in the case of a mixture of gases.

PROCEEDINGS AND NOTICES OF SOCIETIES.

FARADAY SOCIETY.

The following paper was read at the meeting held on April 23, 1927. :

Methods of Calculation of Activity Coefficients. By MERLE RANDALL, University of California, Berkeley, California.

A large portion of the data from which activity coefficients can be calculated has been studied in this laboratory. The methods of calculation have been gradually developed and modified in such a way that the experimental results from the various sources can be directly compared. Graphical methods in which small experimental differences, especially in the dilute solutions, are made evident have been found to be the most satisfactory, both from the standpoint of rapidity of treatment and the ease with which a weighted mean of all the data can be obtained.

It is the purpose of this paper to present the methods, some of which have not been previously described, which are most used. No attempt will be made to develop the theory but for the notation and derivation of the fundamental equations the reader is referred to the work of Lewis and Randall.

Composition is expressed throughout as molality (mols. per 1,000 g. of water in vacuum). Although it may appear to be an unimportant detail, the error involved in converting the data, when expressed in mols per litre, is often greater than that of the experiments themselves and prevents the full use of otherwise excellent data. The composition of a solution when expressed as mols. per litre changes with the temperature owing to the expansion of the solution when heated. In a few cases the transformation to molalities has been found impossible, and we have used a different activity coefficient referred to mols. per litre; but as it is almost impossible to determine the temperature coefficient of such a quantity its use is limited to the temperature at which it was determined.

The determinations of the activity of the solute may be divided into two classes; first, those which determine the relative activity of the solute and, second, those which determine the activity of the solvent and, by means of the partial molal equations, give the activity of the solute. Simple functions of the experimental results are found and presented in such a form that the results of each class may be compared. Although we shall discuss only the aqueous solution, the procedure may be readily adapted for use with non-aqueous solutions.

ACTIVITY COEFFICIENTS OF AQUEOUS SOLUTIONS FROM DETERMINATIONS OF THE ACTIVITY OF WATER.

The following experimental methods all give the activity of the water: freezing-point lowering, vapour pressure lowering, boiling-point raising, osmotic pressure, dew point lowering, distribution ratio of the solvent and, in the case of a few solvents, measurements of the electromotive force in which the solvent is the substance involved in the electrode reactions.

Two of these methods, the freezing-point lowering and the boiling-point raising, give the activity of the water at the freezing- or boiling-point of the solution rather than at a constant temperaure, but fortunately the change of the activity with temperature is small and we have methods of accurately estimating this change.

Freezing-point Lowering.—For the freezing-point lowering, Lewis and Randall used a divergence function,

$$j = 1 - (\theta / \nu \lambda m), \quad . \quad . \quad . \quad . \quad (1)$$

where θ is the freezing-point lowering, or the boiling-point raising, ν is the number of molecules formed per molecule of solute, λ is a constant = 1.858, and m is the molality (mols. per 1000 g. water).

Boiling-Point Raising. — Randall and Adams have used Equation I for all the available data for aqueous solutions of electrolytes. At the boiling-point λ has the value 0.5125, but this value varies slightly with the barometric pressure.

Vapour Pressure Lowering.—For the other experimental methods the divergence function h of Lewis and Randall was generalised by Randall and White,

$$h = 1 + (55.51 \ln a_1)/(\nu m) \quad . \quad . \quad . \quad . \quad (2)$$

For vapour pressure lowering we substitute for $\ln a_1$,

$$\ln a_1 = -\frac{p_1{}^0 - p_1}{p_1{}^0} - \frac{1}{2}\left(\frac{p_1{}^0 - p_1}{p_1{}^0}\right)^2 - \quad . \quad . \quad . \quad (3)$$

where p_{10} is the vapour pressure of the pure solvent and p_1 is the vapour pressure of the solution.

Osmotic Pressure.—For osmotic pressure we substitute for $\ln a_1$

$$\ln a_1 = -\frac{1}{RT}\int_{P_0}^{P} \bar{v}_1 dP \quad . \quad . \quad . \quad . \quad (4)$$

where R is expressed in c.c. atmos., P_0 is the pressure on the solvent in the standard state, P the pressure on the solvent in osmotic equilibrium with the solution, $(P - P_0)$ is the osmotic pressure, and $\bar{v}_1$ is the partial molal volume of the solvent. The value of the integral is found by plotting $\bar{v}_1$ as ordinate, the osmotic pressure as abscissa, and taking the area under the curve to the pressure measured. Whence,

$$h = 1 - (55.51 \times \text{Area})/(82.07\ \nu m T) \qquad (5)$$

Or, if the solution is dilute, we may take $\bar{v}_1$ as constant and equal to the molal volume, whence

$$h = 1 - 12.185\ (P - P^0)/(\nu m T).\ \text{(approx.)} \qquad (6)$$

Dew Point Lowering. Randall, McBain and White reduced the dew point lowering to the equivalent vapour pressure and then used Equation 3.

The distribution and electromotive force measurements give a_1 or $\ln a_1$ which can be substituted directly in Equation 2.

Non-Electrolytes.—In the case of non-electrolytes Lewis and Randall assumed h/m or j/m to approach constancy in the dilute solutions. There are no reliable data to test this assumption. The values of the function are not very large, but within the limits of the experimental error it has been verified by Randall for the freezing-point data, by Randall and Adams for the boiling-point data, and by Randall and Batchelder for the osmotic pressure data. Bury has deduced the limiting value of j/m at $m = 0$, by showing that it is equal to the negative of the slope of the curve of θ/m plotted against θ (B plot of Lewis and Randall). Bury's device is especially valuable as it uses the data in the more concentrated solutions, which are relatively the most accurate, as an aid in determining the limit at $m = 0$.

Determinations by these methods can be plotted with j/m or h/m against m on the *same piece of paper*, or they may be plotted on transparent paper and superimposed for the purpose of aiding in the selection of the most probable value.

The value of the activity coefficient is then given by

$$\log \gamma' = -\frac{j}{2.303} - \frac{1}{2.303}\int_0^m \frac{j}{m}\,dm + 0.00025\int_0^m \frac{\theta}{m}\,d\theta - 55.51\int_0^m \frac{1}{m}\,dx \qquad (7)$$

where the value of the first integral is the *area under the curve of j/m against m.* The value of the second integral is small except in concentrated solutions. The value of the last integral, which depends upon the heat of dilution, is also small. These are fully discussed by Lewis and Randall. In the case of the h function the second and third integrals do not appear, and the value of the activity coefficient is at the temperature of the measurements.

Dissociable Substances and Electrolytes.—Randall and White have shown that the *values of $j/m^{\frac{1}{2}}$ or of $h/m^{\frac{1}{2}}$ for strong electrolytes* when plotted against $m^{\frac{1}{2}}$ will approach limiting values at $m = 0$, which are the same for each valence type. This limit may be obtained empirically or from the Debye and Hückel theory which requires a slightly different limit for each temperature owing to a change in the dielectric constant of the water. For electrolytes, therefore, we plot $j/m^{\frac{1}{2}}$ or $h/m^{\frac{1}{2}}$ against $m^{\frac{1}{2}}$ and obtain the activity coefficient from the equation,

$$\log \gamma' = -\frac{j}{2.303} - \frac{2}{2.303}\int_0^m \frac{j}{m^{\frac{1}{2}}}\,dm^{\frac{1}{2}} + \frac{0.00025}{\nu}\int_0^m \frac{\theta}{m}\,d\theta - \frac{55.51}{\nu}\int_0^m \frac{1}{m}\,dx \qquad (8)$$

where the first integral is the area under the curve of $j/m^{\frac{1}{2}}$ and the others are the same as those in Equation 7.

We are thus able to use the same plot to obtain the activity coefficient from measurements by any of the methods which measure the activity of the solvent. We may also compare this plot with that of similar salts by superimposition. If the substance is not a typical strong electrolyte, as an alkali nitrate, or barium nitrate or sulphuric acid, then the plot of $j/m^{\frac{1}{2}}$ will rise above the curve of other salts of the same type in dilute solution, but the curve will approach the same limit, at $m = 0$. If the electrolyte is only moderately strong, as in the case of cadmium chloride, the rise in the dilute end may amount to a decided peak in the curve. In general, if the salt is highly hydrated in solution then the

$\gamma/m^{\frac{1}{2}}$ curve is low and the values of the activity coefficient are high. For salts of about the same degree of hydration, the weaker salts, or those having an ionic diameter less than the distance of nearest approach of the ions, will have curves lying above the curves of the stronger salt.

Activity Coefficients of Aqueous Solutions from Determinations of the Activity of the Solute.

The activity coefficient as determined from the activity of the solvent at various temperatures may be corrected to any other temperature by aid of the values of the partial molal heat content and capacity, and the results shown by a plot of log γ against the square root of the ionic strength, $\mu^{\frac{1}{2}}$. We shall show that the results of the measurements by all other methods may be transformed so that log γ plus a constant may be plotted on the same scale against the square root of the ionic strength. Then by superimposing all the curves the best value of the constant in each case can be determined and the several curves averaged.

Electromotive Force.—From the electromotive force of cells without liquid junctions in which the electrodes react in such a way as to form in solution the substance whose activity is desired, we may write

$$\log\gamma - \frac{E^{0}}{(0.00019844\ \nu T)/N} = -\frac{E}{(0.00019844\ \nu T)/N} - \log m_{\pm} \qquad (9)$$

where E is the measured electromotive force, ν the number of ions formed from each molecule of dissolved substance, N the number of equivalents of electricity per molecule of solute formed, $m_{\pm}$ the stoichiometric mean molality, and E^0 is the standard *E.M.F.* or the *E.M.F.* when the ions of the solute are at unity activity. The value of the constant is to be obtained by reference to the log γ vs. $\mu^{\frac{1}{2}}$ plot. Of course, a primary extrapolation to $m = 0$ can be made, using the theoretically required slope at the axis as an aid. The standard *E.M.F.*, E^0, equals const. × $(0.00019844\nu T)/N$.

In concentration cells without liquid junctions the following equation is used:

$$\log\gamma + \text{const.} = -\frac{E}{(0.00019844\ \nu T)/N} - \log m_{\pm} \quad . \quad . \quad (10)$$

where $m_{\pm}$ is the mean molality of the ions at the various concentrations. In making the plot against $\mu^{\frac{1}{2}}$, log $\gamma \pm$ const. = − log $m_{\pm}'$, where $m_{\pm}'$ is the fixed concentration, is also used as one of the points. The constant when found is really − (log $m_{\pm}'$ + log γ').

Vapour Pressure of the Solute.—The activity of the solute is proportional to the fugacity of the solute in the gas, or, as a first approximation, proportional to the partial pressure of the solute. Hence we find log a_2 = log p + cons., or

$$\log\gamma + \text{const.} = (1/\nu)\log p - \log m_{\pm} \quad (11)$$

Distribution Ratios.—If the activity of the solute is proportional to the mol. fraction of the solute in a second solvent, then

$$\log\gamma + \text{const.} = (1/\nu)\log N_2 - \log m_{\pm} \quad . \quad . \quad . \quad (12)$$

or, in general, if γ_u is the activity coefficient of the solute in the second phase, then

$$\log\gamma + \text{const.} = (1/\nu\ \log(\gamma_u N_2) - \log m_{\pm} \quad . \quad . \quad (13)$$

The constant is the logarithm of the distribution ratio at infinite dilution.

Solubility of Salt in a Mixture of Electrolytes.—The activity coefficient is proportional to the reciprocal of the mean molality of the ions of a saturated solution of a moderately soluble salt in water, for since a_2, the activity of the salt, is constant (solid phase present),

$$\log a_2 \doteq \log(m_{\pm}\gamma) \quad . \quad . \quad . \quad . \quad (14)$$

$$\text{and } \log\gamma + \text{const.} = \log(1/m_{\pm}) \quad . \quad . \quad . \quad (15)$$

If the salt whose ions are added have the same characteristics, *i.e.*, activity coefficient, as the saturating salt the activity coefficient curve of the saturating salt would be continued without a break, but if the added salt has different characteristics there will be a break. We therefore plot the reciprocal of the mean molality

against the square root of the ionic strength. By comparison of the curves obtained with the curves for various electrolytes which we would expect to have activity coefficients of about the same values as those of the saturating salt we are able to obtain the value of the proportionality factor or constant.

The Equilibrium Constant of a Reaction. —If we consider a reaction in which only pure solids, liquids, gases or weak electrolytes and equivalent amounts of positive and negative ions are formed from solids, liquids, gases or weak electrolytes, we may obtain the activity coefficient of the dissolved salt in a way similar to that of moderately soluble salts. Consider a reaction such as

$$AgCl(s) + 2NH_4OH(aq) = Ag(NH_3)_2^+ + Cl^- + 2H_2O;$$

$$K'_m = \frac{m\,Ag(NH_3)_2 \times m(Cl^-) + a^2(H_2O)}{a^2(NH_4OH)} \quad . . (16)$$

which was studied by Randall and Halford or

$$CaCO_3(s) + CO_2(g) + H_2O(l) = Ca^{++} + 2HCO_3^-;$$

$$K'_m = \frac{m(Ca^{++}) \times m_2(HCO_3^-)}{p(CO_2) \times a(H_2O)} \quad . . . . (17)$$

which has been studied by Randall and Tamele. The equilibrium constant is written so that only one mol. of the salt being considered is formed. The activities of the solids are constant; those of the weak electrolytes can be determined from their vapour pressure, distribution ratio, or, as a first approximation, may be taken equal to the molality, if the solution is dilute. The activities of the gases are approximately equal to their pressure in atmospheres, or the fugacity can be found. The activity of the water is easily estimated to within a few tenths of a per cent. The activities of the ions are equal to the activity coefficient times their molality. If the stoichiometric molality of the ions and the activity of the other substances are substituted in the equilibrium expression it is seen that the activity coefficient is given by the equation,

$$\log \gamma + \text{const.} = (1/\nu) \log K'_m . . . (18)$$

The plots of $\log \gamma$ + const. and of $\log \gamma$ against $\mu^{\frac{1}{2}}$ are now superimposed, and by the aid of similar plots of the activity coefficients of salts of similar type the best values are selected. We have thus been able to compare data determined by the various methods. Some of these methods give data that are more reliable in one range than in another, but the average result obtained by this procedure is the best that can be obtained.

Interpolation of Activity Coefficients.—A modification of an equation of Brönsted's has been suggested by Randall and Breckinridge.

$$(\log \gamma)/\mu^{\frac{1}{2}} = A + B\mu^{\frac{1}{2}} + C\mu + . . . (19)$$

in which A, B and C are constants. A plot of $(\log \gamma)/\mu^{\frac{1}{2}}$ against $\mu^{\frac{1}{2}}$ is nearly a straight line for strong electrolytes, but for moderately strong electrolytes there is a minimum near the dilute end corresponding to the maximum referred to in discussing the $j/m^{\frac{1}{2}}$ against $m^{\frac{1}{2}}$ curves. The intersection on the axis is at A, which corresponds to the slope of the $\log \gamma$ against $\mu^{\frac{1}{2}}$ curve near $m = 0$.

SUMMARY.

Methods of calculating the activity coefficient of the solute from that of the solvent are suggested in which the results from all the different methods are brought into the same plot. (j/m vs. m and $h/m^{\frac{1}{2}}$ vs. $m^{\frac{1}{2}}$ plots.)

The results of the previous methods and those from measurements which give the activity of the solute are correlated in such a way that the plots may be superimposed and the best average values selected ($\log \gamma$ + const. vs. $\mu^{\frac{1}{2}}$ plots.)

A method of interpolating the activity coefficients of strong electrolytes is suggested. ($(\log \gamma)/\mu^{\frac{1}{2}}$ vs. $\mu^{\frac{1}{2}}$ plots.)

ASSUMPTIONS AND POSTULATES.

A perfervid minister in the United States has written a book in which he asserts that he has demolished all the arguments in favour of evolution by the dead and also living scientists of all ages and all lands.

General Notes.

EMPIRE MINING AND METALLURGICAL CONGRESS.

On August 13th the British delegates to the Second (Triennial) Empire Mining and Metallurgical Congress being held in Canada in August and September, sailed from Southampton on the S.S. "Alaunia." The Honourable P. C. Larkin, High Commissioner for Canada in London, has sent to each of the delegates a personal letter offering his best wishes for their comfort and enjoyment during the voyage and the subsequent tours through Canada.

SAFETY IN MINES RESEARCH BOARD: ANNUAL REPORT.

The Fifth Annual Report of the Safety in Mines Research Board—that for the year 1926 has just been published by H.M. Stationery Office (price 9d. net). The year 1926 marked the virtual completion of the new Research Station for large-scale experiments at Buxton and the commencement of the building of the Board's new laboratories at Sheffield. The Board's annual expenditure (mainly derived from the Miners' Welfare Fund) remained at about £50,000. As in previous years, the Report is mainly devoted to brief accounts of the progress of the numerous researches which are being carried out either directly under the Board or Committees of the Board, or at Universities and other centres with the aid of funds supplied by the Board.

The subjects of research included problems relating to coal dust explosions, firedamp explosions, spontaneous combustion of coal (including the treatment of gob-fires), the safe use of electricity in coal mines, mining explosives, safety lamps, devices for trapping dust generated by rock drills, devices for winning coal without explosives, falls of ground, wire ropes and the control of mine temperatures. New researches were begun under several of these heads. Thirteen reports were published by the Board during the year, and a list is given of many other papers relating to the researches written by members of the staff and published in scientific journals, etc.

The Report also embodies an account of the progress of the health enquiries carried out under the supervision of the Health Advisory Committee, notably the enquiries with regard to the injurious effects of certain rock dusts.

WHOLESALE PRICES IN JULY.

Board of Trade Index Number.

In July wholesale prices, as measured by the Board of Trade Index Number, averaged 0.5 per cent. less than in June, the index numbers for the two months being 84.9 and 85.3 respectively (1924 = 100). Foodstuffs were cheaper by 1.6 per cent., while industrial materials were dearer by 0.2 per cent. The averages for each of the three food groups show reductions, cereals falling by 0.6 per cent., meat and fish by 1.8 per cent., and other foods by 2.4 per cent. Rises of 3.2 per cent. in cotton, 2.0 per cent. in other textiles, and 0.6 per cent. in miscellaneous industrial materials were almost balanced by falls of 1.2 per cent. in iron and steel and 2.0 per cent. in other metals and minerals.

BRITISH STANDARD FLAME-PROOF TYPE PLUG AND SOCKET.

The British Engineering Standards Association have just issued a specification for a flame-proof type plug and socket, heavy duty, 100 ampere, for voltages not exceeding 660. The plugs and sockets described in this specification are primarily intended for use in connection with coal-cutting machines and the like portable apparatus in mines. The specification deals only with the dimensions necessary to secure interchangeability between plugs and sockets and with certain electrical and mechanical requirements. It does not specify a fully detailed design. In order to make the specification complete, the British Standard Definition of Flame-proof Enclosure (including explosion-proof) for electrical apparatus from the British Standard Specification No. 229-1926 is included.

Copies of this new British Standard Specification, No. 279-1927, may be obtained from the Publications Department, British Engineering Standards Association, 28, Victoria Street, London, S.W.1., or from the publishers, Messrs. Crosby, Lockwood and Son, 7, Stationers' Hall Court, London, E.C.4., price 2s. 2d., post free.

CANADIAN SALT PRODUCTION MAKES NEW RECORD.

The steady increase in salt production in Canada reported in recent years continued during 1926, the report of the Dominion Bureau of Statistics showing an output of 262,547 tons. This compared with the previous high record of 233,746 tons made in 1925. This year's output value was reported at $1,480,149, as compared with $,410,697 for the 1925 production.

ROYAL SOCIETY OF ARTS.

THOMAS GRAY MEMORIAL TRUST. PRIZES FOR THE IMPROVEMENT AND ENCOURAGEMENT OF NAVIGATION.

Under the will of the late Thomas L. Gray, the Royal Society of Arts has been appointed residuary legatee of his estate for the purpose of founding a memorial to his father, the late Thomas Gray, C.B., who was for many years Assistant Secretary to the Board of Trade (Marine Department).

The Council now offer the following prizes :—

(i) A prize of £100 to any person who may bring to their notice a valuable improvement in the Science or Practice of Navigation proposed or invented by himself in the years 1927 and 1928.

In the event of more than one such improvement being approved, the Council reserve the right of dividing the amount into two or more prizes at this discretion.

Competitors must forward their proofs of claim on or before December 31st, 1928, to the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2.

(ii) A prize of £50 for an essay on the following subject :— " The Practice of Navigation in the Mercantile Marine."

The essay must be based on the actual methods used by the writer during his career, with special reference to the instruments used as aids to navigation, and the effect of stowage of cargo on the steering, speed and safety of the vessel.

Competitors must send in their essays not later than December 31, 1928, to the Secretary, Royal Society of Arts, at the above address.

The essays must be typed or clearly written. They must be sent in under a motto, accompanied by a sealed envelope enclosing the author's name.

The Judges will be appointed by the Council.

The Council also reserve an option on holding the prize or of awarding a smaller prize or prizes, if in the opinion of the Judges no suitable essay is submitted.

The Council also reserve an option on the copyright of the successful essay.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

19,868.—Calcott, W. S.—Production of tetra-ethyl lead. July 26th.

20,110.—I. G. Farbenindustrie Akt.-Ges. —*Manufacture of sulphur dye-stuffs.* July 28th.

19,649.—Compagnie de Bethune.—Catalysers for synthesis of alcohols. July 25th.

20,275.—Fagelston, I. — Oxidation of ammonia. July 30th.

20,193.—Monsanto Chemical Works.—Production of benzoic acid from phthalic anhydride. July 29th.

Specifications Published.

274,558.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of derivatives of the anthraquinone series.

274,700.—Holliday & Co., Ltd., L. B., Shaw, C.—Manufacture of chloranil and bromanil.

265,984.—Naamlooze Vennootschap Silica en Ovenbouw Mij.—Recovery of benzenes from coal-gas.

268,375.—I. G. Farbenindustrie Akt.-Ges. Manufacture of alkylated or cyclo-alkylated aryl-sulphonic acids.

Abstract Published.

271,725.—Peroxides of organic acids.—McKee, R. H., 210, Chrystie Heights Street, Leonia, New Jersey, U.S.A.

In the manufacture of peroxides of organic acids by the action of a peroxide solution on an organic acid chloride, the hydrogen ion concentration of the reaction mixture is maintained near the neutral point by the use of a buffer compound. Generally, the hydrogen ion concentration is maintained at or about ρ-H. 7.5, but benzoyl peroxide is preferably made at or about a concentration ρ-H. 8.5, and some other peroxides may be made at or about a concentration ρ-H. 6. The preferred buffer compound is disodium phosphate, but other compounds such as sodium bicarbon-

ate or borax may be used. The process *may be carried out by adding disodium* phosphate to a dilute solution of hydrogen peroxide in such an amount that in the subsequent reaction with the acid chloride, for example phthalyl chloride, about 90 per cent. of the disodium phosphate will be converted into monosodium phosphate. The phthalyl chloride is then stirred or sprayed into the mixture, the temperature being kept at 40-65° F., whereafter the separated peroxide is washed and dried. For fumaryl peroxide a reaction temperature of 30-40° F. is used. The process may be modified by using less disodium phosphate and, when about half of the acid chloride has been added, adding caustic soda or soda ash in amount sufficient to re*convert into disodium phosphate the mono*sodium phosphate formed in the reaction. Alternatively, the caustic soda or soda ash may be added slowly during the reaction, in which event the amount of the buffer compound may be further reduced.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

TOPHET.

481,775.—Chemical substances prepared for use in medicine and pharmacy. —Lamberts (Dalston) Limited, 60, 62, Queen's Road, Dalston, London, E.8., and 49a, 49b, 49c, and 49d, Parkholme Road, Dalston, London, E.8. August 3rd.

KAPUTINE.

480,848.—Chemical substances prepared for use in medicine and pharmacy. —The General Kaputine Syndicate, Limited, Lilley Street Laboratories, Lilley Street, Queen's Road, Manchester. August 3rd.

BOCRA.

481,790.—Chemical substances used in manufactures, photography, or philosophical research, and anti-corrosives. — Thomas Aspinall, Limited, 6, 8 and 10, Bank Street, and Charles Chemical Works, Water Street, Bolton, Lancashire. August 3rd.

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OBSERVATIONS ON SOLUBLE META-TUNGSTATES.

By EDGAR F. SMITH.

It is well known that Scheibler pronounced barium meta-tungstate (*Jour. prakt. Chem.*, LXXXIII 1861, p. 307) the most important salt of meta-tungstic acid. He prepared it by mixing a hot concentrated solution of sodium meta-tungstate with an equivalent amount of dissolved barium chloride, containing a few drops of hydrochloric acid. If the sodium salt was pure then a precipitate did not appear and on cooling the liquid deposited beautiful crystals of barium meta-tungstate. But at this point Scheibler wisely remarked there generally was a precipitate, " weil es sehr schwer hält, ein ganz reines meta-wolframsuares Natron herzustellen." Hence, the writer on repeating this recommendation with several hundred grams of sodium meta-tungstate as prepared by himself, was greatly surprised at the mass of impurity which made its appearance. It was removed. From the filtrate, on cooling, a copious amount of nicely crystallised barium salt separated. This was again dissolved in hot water in which there was a little hydrochloric acid. More flocculent material settled out, and the barium salt which later put in its appearance was subjected to like treatment, until there was absolutely no deposition on dissolving the salt in slightly acidulated water. The barium salt crystallising out thereafter was in large forms with a waxlike lustre. The water employed in the re-crystallisation of this salt was kept free from ammonia. Indeed, air containing ammonia vapour should be avoided. Scheibler considered air holding tobacco fumes detrimental. A portion of the barium salt so highly purified may easily be transposed by a calculated amount of purified sodium carbonate into a pure sodium meta-tungstate, but in this study the pure barium salt was transposed with a calculated amount of pure lead nitrate. When their hot aqueous solutions were mixed there was at first no precipitate, or at least, a very slight one which was filtered out, and the filtrate on cooling, with constant stirring, eventually solidified to a crystalline mass. This crystal magma was thrown upon a filter and after the adherent liquor had drained away the mass was pressed out thoroughly, and the attempt made to dissolve it " in a large volume of hot water," using the language of Vincent Forcher. There was a large insoluble white residue. The filtrate from it, concentrated at temperatures not exceeding 65° or 70 C., continued to show a separation which was not crystalline. As previously remarked the concentrated water solution at last continued clear and in the course of several days contained silky crystals. These were collected and subsequently analysed. They were not pure lead meta-tungstate, but the ratio of lead oxide and tungsten trioxide approached 1 : 4. They were contaminated with the white powder, which could not be removed from them. Every effort was made to effect this. The conclusion, therefore, was reluctantly reached that the white residue, so often mentioned in the earlier paragraphs, was a hydrolytic product derived from normal lead meta-tungstate.

Lotz, in his work, when speaking of the solubility of lead meta-tungstate in water for the purpose of its purification omits to say whether the water so employed was *hot* or *cold*. The writer, therefore, subsequently treated the "crystal magma," obtained in the beginning, with a large volume of water of the room temperature. Solution ensued with only small portions of a residue. After filtration the rather large volume of liquid was placed on an iron plate and a small flame under the latter. As the liquid acquired heat it slowly became more and more turbid until in a short while there separated a dense white insoluble powder, as happened, in following the procedure, of Vincent Forcher. And these several white insoluble residues gave results on analysis approximating very closely the salt :

$$PbO.WO_3.2\,1/2H_2O.$$

Had, however, the filtrate from the original lead salt prepared by Lotz, not been heated but allowed to slowly evaporate spontaneously, there appeared after a week or two long silky needles which proved to be the normal lead meta-tungstate. This is a beautiful salt, consisting of short or long silky needles. Those collected by the writer were preserved and dried between bibulous paper and after standing for a day or more were introduced into weighing bottles and there preserved until analysis was made.

The analytical results led to the formula :

$$PbO.4WO_3.7H_2O,$$

requiring

72.67 per cent. WO_3
17.46 ,, ,, PbO
9.86 ,, ,, H_2O

while the figures actually found and recorded in the order the analyses were made were :

%	I.	II.	III.	IV.	V.
WO_3	72.84	72.64	72.84	73.04	73.52
PbO	16.98	17.87	17.06	—	17.27
H_2O	10.18	9.01	10.30	—	9.21
	100.00	99.46	100.20	—	100.00

Many other analyses were carried out, but as they were of a single constituent, made chiefly for confirmatory purposes they are not given. However, the evidence is clearly in support of the existence of a normal lead meta-tungstate, which continues under study with the hope that it may be prepared of such purity as to use it for the re-determination of the atomic weight of tungsten.

The analysis of this salt has every appearance of simplicity; actual experience demonstrates that difficulties are frequently encountered. It is well to work with from one to two grams of material. The latter dissolves quite easily in a small volume of concentrated hydrochloric acid, which after contact with the substance and after complete decomposition is everywhere apparent, may be evaporated away. The residue should be treated a second time with strong acid and the latter gradually expelled. The residual tungsten trioxide and lead chloride should be completely dried out at a temperature of 250° C. Water and acid may then be placed over the residue. Care must be taken to bring the lead chloride into solution. It manifests a tendency to cling to the tungsten trioxide and in all cases should be examined for this acid.

Another analytical procedure was followed. The weighed lead meta-tungstate was dissolved in pure sodium or potassium hydroxide. In this alkaline solution a platinum gauze was suspended and the electric current allowed to act. The lead was completely deposited as a bright metallic coating. After dipping the gauze with its lead in water once or twice, to eliminate mother-liquor, it was exposed to the action of warm dilute nitric acid and the resulting solution of lead nitrate then evaporated to dryness in a weighed porcelain crucible. The residual lead nitrate was ignited to lead oxide and weighed as such.

The alkaline liquid from which the lead was electrolytically precipitated was made acid with sulphuric acid, the tungstic acid was thrown out as the quinine salt by a slight excess of a solution of quinine sulphate. The quinine tungstate was filtered after standing several hours. It was washed with water containing quinine sulphate. After drying it was ignited in platinum crucibles to tungsten trioxide. The analyst should not forget that quinine tungstate precipitated from solutions containing a great deal of alkaline salts is likely to be contaminated by the latter. When this occurs the ignited tungsten trioxide is greenish in colour, and not yellow, as it should be and will be if it had previously been completely washed.

A third method of analysis was also employed with success. It consisted in exposing in a porcelain boat resting in a combustion tube, a weighed amount of lead meta-tungstate, and while heating the latter to a temperature of 200° C.—conducting over it a gentle stream of carbon tetra-

chloride. Lead chloride remained in the boat and was weighed. The receiver of the apparatus contained water in which the volatile tungsten body collected and was later changed to tungsten trioxide.

Chemists engaged with work in which sodium or ammonium meta-tungstates enter are quite familiar with the methods for the preparation of these salts as recorded in the literature of numerous handbooks devoted to chemistry, and probably hold widely divergent views in respect to their merits It is not proposed to make an exhaustive review of them but to rest content with a statement of methods upon which the writer has come to rely as being worth while and dependable.

In making sodium meta-tungstate one may supersaturate a boiling solution of normal sodium tungstate ($Na_2WO_4.2H_2O$) with precipitated tungstic acid; or, what is preferable 5 :12- sodium tungstate ($5\ Na_2O.12\ WO_3.28\ H_2O$) may be handled in the same fashion. Points that should be observed in carrying out the second procedure are, first — that the 5 : 12- salt be pure. As many as twelve, fifteen or more recrystallisations of this salt from water are in no sense useless. Its solution later need not be boiled while introducing the tungstic acid. It is enough to have the solution in a large, capacious flask (round bottom, if possible), and the liquid held at a temperature from 70 to 75° C. Into this bring an emulsion of tungstic acid which has been warmed to a temperature of 65 to 70° C. On twirling the hot 5 : 12 salt- solution about after the addition of each portion of the tungstic acid emulsion, the latter rapidly disappears until all of it capable of absorption has been dissolved. Immediate filtration from excessive material may occur, although the writer has found it just as well to let the liquid stand over night. The filtration then will yield a colourless, clear liquid. This may be concentrated at a temperature not exceeding 70° C., and when sufficiently reduced allowed to remain covered in the cold until the sodium meta-tungstate crystallises. The crystals will be colourless and will exhibit none of the stickiness on placing them between the fingers which is noticed so often after the hasty preparation of the salt and which stickiness is due to undesired impurities. Perhaps a recrystallisation of this product of $Na_2O.4WO_3.10H_2O$ may seem desirable. Let it be done and a portion of it be tested for its purity by transforming it into barium meta-tungstate as described in an earlier paragraph. If there be no permanent residue on treating it with a slightly acidulated barium chloride solution, the operator may confidently declare that he has a pure product—usually so extremely difficult to get.

And what scheme shall the student pursue in making pure ammonia meta-tungstate? The old method of boiling a solution of 5 : 12- ammonium salt in water for five or six days is the customary course. The product is often much discoloured (due to reduction products of tungstic acid) and requires a searching purification. This is tedious and a bit discouraging when operating with large amounts of substance. Yet, the majority of chemists follow the plan. Scheibler, familiar with all the disagreeable features of the method, recommended as superior in that not so much time was expended, and that the end product was vastly purer—to reduce any weighed amount of the dry 5 : 12- salt to a powder which was spread out in a thin layer on the sides of a shallow dish—porcelain or platinum—suspended in an oil bath where the prevailing temperature ranged from 280 to 300° C., and maintained at that point until escaping ammonia gas could no longer be detected. The residue was then heated with hot water. Considerable insoluble tungsten trioxide appeared, and the solution from it gave colourless crystals of ammonium meta-tungstate (*Jour. prakt. Chem.*, LXXX, p. 204). The writer worked a long while over this method, hoping it would really prove to be a good procedure, but such it has failed to be.

The method which he has come to regard as the most satisfactory is analogous to the customary method applied in making sodium meta-tungstate, *viz.*—

Saturating a hot solution (75° C.) of pure 5 : 12- ammonium tungstate with a warm emulsion of tungstic acid. The saturation proceeds rapidly. The filtrate from insoluble substances may be concentrated at 70° C. or permitted to evaporate spontaneously. The product is very pure. The undesirable features of the other two schemes do not appear. Why this simple course has not been tried before is not easily comprehended. In the other plans (1 and 2) the thought appears to be to get rid of ammonia; in this last plan the aim is to add tungstic acid to ammonia—to super-saturate, so to speak, the salt with tungstic acid. Other work along these lines is in progress.

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THE STRUCTURE OF SILICATES.

By W. L. Bragg, O.B.E., M.A., F.R.S., Langworthy Professor of Physics, Victoria University of Manchester.

(Extract of paper read before the Royal Institution of Great Britain, May 20 ,1927.)

At a time when the fundamental conceptions of the structure of matter are being changed so rapidly, when every six months witnesses the birth of a new analytical method of dealing with the very foundations of our physical science, the study of the particular crystal patterns which form the subject of my lecture must seem a trivial matter. Yet similar studies have played their part in the extraordinary development of physics in the last decade, and I hope that the refinement of our methods of analysis, such as is represented by the present examples, will in turn prove to be of use. The results of the particular investigations which I propose to describe are interesting in themselves because silicates form so large a proportion of the earth's solid crust, and certain artificial forms are so largely used for technical purposes. I think, however, that it is right to stress another aspect of this study. We are trying to improve the technique of the X-ray examination of solid bodies, to increase the resolving power of our instruments so that we can see finer detail and deal with more complicated structures. It is at present a tedious and difficult task to discover how the atoms are arranged in these bodies; even when some experience in handling them has been obtained one has to devote much time and concentration to each particular case. Yet every solution makes the next problem easier to attack, and when we look back on the last few years' progress I think a very real increase in power of analysis is evident as the result of the efforts of many workers in this field.. It is this advancement of technique in which personally I am particularly interested. In trying to improve our instrument we examine with it from time to time a new type of solid body—these silicates being an example—and we describe what we see. I am not competent to discuss the discoveries we make; I can only hope that the casting of light from a new angle may be useful to those who have made a life-long study of these particular types of compound. I feel that my main contribution must be a demonstration of what knowledge it is possible to attain by careful X-ray examination.

The silicates present a highly interesting series of problems for X-ray analysis. The numerous crystalline forms have been carefully studied because of their importance to the mineralogist, and they show most interesting relationships and wide variation in composition. It is estimated that oxygen, silicon, aluminium and iron by themselves compose about 87 per cent. of the earth's crust, and if we add four other elements, calcium, sodium, potassium and magnesium, they amount together to 98 per cent. These are the elements that build up the compounds we are considering, and their relative proportions are a reflection of the fact that most of the earth's crust is composed of compounds of metals with silicon and oxygen.

The silicates occur as solid bodies, whose atoms are arranged in crystalline patterns. These patterns are often very complex, and it would be difficult to attack them by general methods unless some guiding line could be followed through the intricate maze. Such a guiding line may perhaps be found in the peculiar part which the oxygen atoms play in building up the structure. Not only are the oxygen atoms the most numerous, but they appear to be the most bulky of the units of which the pattern is woven, so that their predominant size and number make them force the other atoms to conform to certain simple and characteristic arrangements of oxygen atoms which we find occurring again and again as an underlying *motif*, throughout the range of such silicates as have yet been analysed. A few simple examples may help to illustrate this point.

Four spheres, packed together as tightly as possible, assume a tetrahedral arrangement with one sphere standing on three others. Six spheres when packed together take up a form where three of them lie on top of three others. Alternatively we may regard this arrangement as four spheres at corners of a square with one above and one below this square the second arrangement being identical with the first regarded from a different view point.

These very simple groupings of oxygen atoms, with an atom of some other element at the centre of the group, occur again and again in the silicates and in many other compounds. In many cases the group not only has a characteristic shape, but also a characteristic size, the distance between the oxygen atoms having a value of about 2.5 to 2.7 Angstrom units (10^{-8} cm.). In the list of common elements given above it is only sodium, calcium, and potassium which

appear to break up the regularity of this group, and to force the oxygen atoms apart if placed at the group centre. The other elements appear to fit comfortable into the interstices of the oxygen grouping. Since there is a common distance throughout between oxygen atoms, certain atoms of one group can at the same time form part of the next group, and so a continuous structure is built up which may be thought of as a pattern of oxygen atoms with the metal and silicon atoms in its interstices.

This predominance of the oxygen atoms greatly simplifies the analysis of the structures, and makes it easier to visualise the relationships between different types. All these bodies build up a crystalline pattern repeated again and again in space. Now the simplest types of pattern are those such as children are taught to make in the kindergarten, where blocks of the same shape and size, but coloured differently, can be stacked together in geometrical designs. The silicates present rather a fascinating analogy to these kindergarten patterns, the oxygen atoms being the blocks and the other atoms the colouring agent. It is as if a complex pattern were embroidered by the other atoms upon a simple underlying fabric of oxygen atoms.

Using these tests, it appears probable that certain compounds are based on one of the forms of close-packing, and we have examined some of these cases. The close-packing of the oxygen atoms is, however, exceptional, and although in most compounds the four-fold and six-fold groups form the basis of the pattern, this pattern may be of an open type. The various forms of silica, to whose investigation the Royal Institution has made so large a contribution, are beautiful examples of open patterns built of the four-fold groups, and other examples of these lace-work open patterns have been analysed. The closely woven patterns have been choeen for description hete because their basis is the more simple.

In order to understand these frameworks of oxygen atoms, with metal atoms packed in the interstices, it is necessary to bear in mind some of the geometrical laws of pattern-making. If a repeated pattern be formed by stacking together blocks of the same size and shape, but different in colour, the unit of the pattern will be composed of a whole number of blocks. It is always possible to outline the pattern with a series of unit cells, each of which just contains one complete example of the pattern and no more.

When the scattering of X-rays by the crystal is examined, the close-packed arrangement of oxygen atoms shows up strongly. We can consider the effect on the X-rays as composed of that due to the oxygen atoms on the one hand, combined with that due to the atoms of metal and silicon on the other hand. The former leads to a simple and intense diffraction pattern, to be expected from a straightforward cubic face-centred lattice. The aluminium and silicon atoms, which form a complex diffraction pattern within that due to the oxygen atoms alone.

The complex inner pattern contains the information necessary to tell us where the aluminium and silicon atoms are. It is a difficult matter to unravel its story, but it is by no means as formidable as it would have been, had we not known that the oxygen atoms are nearly in this simple arrangement, and that the aluminium and silicon atoms are somewhere within the four-fold or six-fold groups of oxygen atoms.

As another example of this pattern-weaving, the series of compounds Mg_2SiO_4, $MgO_2H_2(Mg_2SiO_4)_2$, $MgO_2H_2(Mg_2SiO_4)_3$, MgO_2H_2 $(Mg_2SiO_4)_4$ may be examined. The dimensional relationships between these crystals (the chondrodite series) have long aroused interest.

Tough very few examples of silicates have yet been analysed, the temptation to draw conclusions from them is irresistible. The most curious feature about the natural silicates is the immense variety in composition which occurs within one and the same mineral species. Stupendous chemical formulæ have to be assigned in order to explain even approximately the relative proportions of the different elements in some well-known types.

It seems to me that the position becomes clearer when we consider the compounds as an embroidery of the metal atoms upon an oxygen Iromework. We may compare the oxygen framework to the steel girder system of a large ferro-concrete building in course of construction, which is intended to be divided into sets of flats. Before the girder system is filled in, its configuration is very simple indeed. Then certain blocks of it are partitioned off into sets of rooms,

each comprising a flat; these flats are the more complex units of pattern in the crystalline structure. The arrangement of the rooms in each flat corresponds to the selection in our oxygen framework of certain spaces in which to put the metal atoms. We can go one step further, and rent our flats to families of slightly different composition, so that a census of the whole building shows a bewildering proportion of types of inhabitants difficult to represent by a definite family formula. This is really the state of affairs with which the chemist is confronted when he attempts to give a formula to many of the silicates.

Some of the very earliest structures which were analysed caused us to revise our ideas of what was meant by the "molecule" of the chemist. In sodium chloride there appear to be no molecules of NaCl. The equality in numbers of sodium and chlorine atoms is arrived at by a chess-board pattern of these atoms; it is a result of geometry and not of a pairing-off of the atoms. This is, of course, not universally true, for this absence of the molecule in solids is in general only found in inorganic compounds. It would appear, however, that the silicates are of this non-molecular type, and that in seeking to assign formulæ to them, and to the hypothetical acids of silicon on which they are based, it should be borne in mind that they are really extended patterns. The relative numbers of their constituent atoms are characteristic of the extended pattern, and essentially a result of their solid state, so that it is doubtful whether a grouping of the atoms into molecules has in this case a meaning. It will be very interesting to see what further light the X-ray results can cast on the relationships in this fascinating series of compounds.

CANADIAN INDUSTRIES.

The best available statistical summary of the business situation in Canada is that published by the Dominion Bureau of Statistics under the title of "The Monthly Review of Business Statistics."

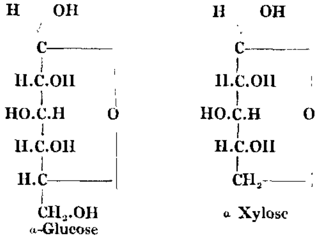
In the last issue it is noted that newsprint, pig iron, steel and automobile production for the first five months of 1927 are well ahead of the levels attained in the corresponding period of 1926. The increased volumes of imports, of cotton, rubber and coal give further evidence of manufacturing activity and this view is also supported by the gratifying level of employment figures throughout industry.

STRUCTURAL RELATIONSHIPS IN THE CARBOHYDRATE GROUP.

By Prof. W. N. Haworth.

(Before the Society of Chemical Industry.)

The fundamental change of viewpoint from which the carbohydrates are now surveyed is to be attributed to the recognition that the common forms of monosaccharides are six-membered heterocyclic compounds. Thus glucose and xylose, the typical hexose and pentose respectively, are shown below.



α-Glucose α Xylose

The same type of ring is present also in galactose, normal fructose, arabinose, in that form of mannose which is related to α-methylmannoside, in rhamnose glucoside and other common sugars of the simplest nature.

The occurrence of galactose derivatives in fruits, and particularly the capacity for the secretion of galactosides displayed by animals, require the admission of a mechanism by which glucoside residues can change to galactose with extreme readiness. This would involve a Walden inversion of the groups at the fourth carbon atom (counting from the reducing group), the remaining groups keeping the same relative positions as in glucose.

Pectin bodies have been shown to contain condensed residues of galacturonic acid, and these residues are nearly always accompanied by the presence of *l*-arabinose. This again reveals the capacity of the plant to oxidise the side chain of the heterocyclic ring to a carboxylic group. The same may serve also to explain why *l*-arabinose occurs freely in nature but rarely in the *d*-form, since *l*-arabinose would readily be derived from galacturonic acid by loss of carbon

dioxide from the side chain, whereas *d*-arabinose would be expected if this sugar were derived initially from *d*-glucose. *l*-Arabinose occurs in fruit gums, particularly in cherry gum, along with condensed arabinose residues. The stereochemical arrangements of theh groupings in *l*-arabinose are seen to be identical with those attached to the first four carbon atoms in galactose.

It is not easy to invent a mechanism for the change from glucose to galactose. The suggestion is made by Prof. Robinson that a preliminary stage is probably the attachment of the hydroxyl group at the fourth carbon atom of glucose to a condensed residue such as phosphoric acid. The hydrolysis of such a phosphoric residue would involve a Walden inversion, since the oxygen of the reducing hydroxyl group would be retained by the phosphorus, and a new oxygen in the incoming hydroxyl group would take its place by a mechanism which is now held to involve always a Walden inversion (compare Phillips and Kenyon.) A development of this suggestion may explain also why *d*-ribose is isolated from certain nucleic acids. The combined sugar in these acids may not be ribose but xylose, inasmuch as hydrolysis of the phosphoric acid grouping involves an inversion of the hydroxyl at the third carbon atom of xylose to give ribose. This inversion may not be complete since Neuberg has detected xylose in the hydrolysis products of certain of the nucleic acids.

The occurrence of mannose in nature is explained by the ordinary Lobry de Bruyn-van Eckenstein transformation from glucose or fructose.

The transformations of other naturally occurring sugars from glucose may be traceable in a similar way. On the other hand, there is the contrary view that nature may have the capacity to form each individual sugar as a primary product. Certainly it would appear that *l*-rhamnose, which is of widespread occurrence and is related to *l*-mannose, cannot be conceived as arising in any direct way from *d*-glucose. Indeed, its formation could be better understood on the hypothesis that it is formed initially from *l*-glucose, the existence of which in nature is doubtful. The configuration of this sugar requires further confirmation, and it would be premature to decide whether *l*-rhamnose and also fucose should be considered as arising from a sugar of the "l"-series or whether they derive directly from *d*-glucose through d-galactose.

In stressing the 6-ring lactol formulæ for normal sugars it is not implied that they persist or react only in this form. It has been shown that the labile γ-sugar derivatives are 5-ring lactols, and the existence of these demands the recognition that the open-chain aldehyde or keto-forms also play an important part in reactions in the carbohydrate group, especially in the presence of bases.

Disaccharides.

The special nature of the hydroxyl group on the fourth carbon atom in glucose, which has been said to be responsible for the glucose-galactose transformation, is seen to have importance also, inasmuch as the biose linking in cellobiose, maltose, and lactose occurs at this fourth position, whilst the two remaining reducing bioses—namely, gentiobiose and melibiose—involve the linking of the second hexose with the hydroxyl in the side chain.

On the other hand, gentiobiose, a disaccharide which has assumed in recent years great importance, is probably widely distributed in nature in glucosides (for example, amygdalin), and is structurally represented by attaching a second hexose through its reducing group to the side-chain hydroxyl group of the first hexose residue.

Again, melibiose is a reducing disaccharide structurally similar to gentiobiose, but suffering in that the second or non-reducing hexose residue is galactose. There is, is however, some doubt about the view taken in the literature that the biose junction is of the β-type. Indeed, certain evidence points to the possibility that this biose junction should be stereochemically represented as α.

Polysaccharides.

The X-ray diagram for cellulose as interpreted by Sponsler and Dorée necessitates the adoption of the new formula for glucose, the dimensions of which fit into the space lattice exactly, whilst this is not the case with the older Fischer formula. Since cellulose breaks down on acetolysis to give cellobiose, the constitution of which has already been commented on, the possi-

bility that the glucose residues in cellulose are linked to some extent if not altogether as in cellobiose, has been obviously considered. Ost and Hess suggest, however, that cellobiose may be a reversion product, and that another disaccharide, cellois0-biose, represents more truly the state of the linking of the glucose residues in cellulose. Since celloisobiose has not, however, been completely characterised, and inasmuch as its existence is held to be a matter of doubt by some chemists, we are thrown back on mere speculation as to the precise position of the linkings of the hexose residues in cellulose. What is clear is that the groups in positions 2, 3, and 6 do not appear to be involved. Hess claims to have determined the molecular weight of cellulose diacetate in air-free acetic acid solution, and to have obtained a value corresponding closely to that required by the diacetate of glucoside anhydride; whilst Pringsheim, heating cellulose triacetate in naphthalene, claims to have been able to recognise triacetylglucose anhydride and to isolate from this by hydrolysis the actual glucose anhydride corresponding with the simple formula $C_6H_{10}O_5$. *The urgent problem in carbohydrate chemistry* is to decide whether cellulose is a substance as we understand the term in chemistry, or whether it is a polymerised product which may vary in complexity according as polymerisation has extended to a greater or less degree; and also whether this type of polymerisation involves a molecular aggregation depending upon the re-adjustment of principal valencies, or whether subsidiary valencies promote this change without calling into play any principal valency.

Trimethyl-δ-arabonolactone, which is crystalline, changes on keeping in a dry atmosphere in the presence of a trace of hydrogen chloride gas, and gives a different crystalline product which is much less soluble in all solvents, has a diminished specific rotation, and a molecular weight about ten times that of the original lacton. It crystallises in the hexagonal system. Moreover, on simple distillation this crystalline polymeride changes back into the crystalline lactone, and this intnerconversion can be carried on any number of times in either direction. The two products are being studied by X-ray methods, and we hope to be able to decide whether in this case principal valencies of the lactone have been called into play. Certainly the chemical properties suggest that such is the case.

RECENT ADVANCES IN OUR KNOWLEDGE OF STARCH.

By Prof. Arthur R. Ling.

Starches may be divided into two main types, (1) transitory starch present in foliage leaves and in other vegetable tissues, *e.g.*, the germinating embryo of seeds, and (2) reserve starch which occurs in the roots, tubers, and stems of plants in the form of granules, differing in form and size according to their origin.

It will be convenient in the first place to consider the nature of reserve starch. So long ago as 1858 Nägeli had put forward the view that starch granules are formed in the amyloplastids of plants by a process of intussusception—increase from without to within—the outer layer being the older and the less hydrated. He considered that this outer layer consisted of a substance to which he gave the name starch cellulose, whilst the innerportion—that which when dissolved in water gave a clear blue coloration with iodine—he called granulose. This view of the formation of starch granules was opposed by A Meyer in 1895. He furnished evidence supporting the view that the granules are formed like crystals by apposition. He called the outer portion α-amylose, and the inner portion β-amylose. Definite evidence that starch granules contain more than one substance was brought forward by Maquenne and Roux, and by Mme. Gatin-Gruzewska, as well as by Fouard. Maquenne called the substance forming the inner portion of the granule "amylose," and he stated that it is present to the extent of 80 per cent. of the dryamylaceous matter. The outer portion of the granules he called "amylopectin." He observed that the property which starch possesses of forming a viscous paste with hot water was due to amylopectin. Fouard, as well as Fernbach, have shown that some of the hydroxyl groups of starch, when in the form of granules, are esterified by phosphoric acid, whilst Samec observed that this was particularly true of amylopectin.

Ling and Nanji (1923) devised several methods of separating amylose from amylopectin, but the matter presented great difficulty. Amylose is present in the granules partly in association with amylopectin, so that only about one half can be extracted by dilute alkalis. Better results were obtained by treating starch paste with barley diastase solution. Under these circumstances amylose is hydrolysed to maltose, whilst amylopectin is depolymerised to αβ-hexa-amylose, a non-reducing polysac-

charide first obtained by J. L. Baker in 1902 and called by him α-amylodextrin. Ling and Nanji were able to show, however, that the polysaccharide contained both α- and β-linkages. Since amylose is completely converted into maltose by barley diastase, whilst amylopectin yields a non-reducing substance, it became possible to estimate the ratio of amylose to amylopectin in starches from the reducing power of the mixed products of hydrolysis by barley diastase. Results obtained in this way showed that the ratio was constant in all starch granules, being 2 parts of amylose to 1 of amylopectin.

Ling and Nanji (1925) refer to this as amylohemicellulose, and believe it to be a calcium-magnesium salt of a silicic and phosphoric ester of α-amylose. Pringsheim and Kusenack (1924) have shown lichenin to be a silicic ester. Amylohemicellulose when hydrolysed with malt diastase is converted quantitatively into maltose. It gives a blue coloration with iodine. Barley diastase is without action on it.

Beazeley has recently carried out an extended piece of research work on amylohemicellulose. It is found that all the cereal starches contain amylohemicellulose which apparently forms in these cases an integral portion of the granule, so that it cannot be separated by physical means. It may be that the layer previously constituted the leucoplast membrane within which the granule was formed. Neither this question nor whether the amyloplastid described by Schimpner consists of amylohemicellulose in the starches of arrowroot and potato is perhaps due to the fact that the rhizome and tuber both contain much more water (over 70 per cent.) and the amylohemicellulose probably remains associated with the cell wall. It is found that the potato tuber itself contains a considerable quantity of the hemicellulose. Commercial rice starch when examined under the microscope is found to contain a few discrete granules, but the majority are aggregates held together by some other substance.

α-Amylose when hydrolysed by a solution of barley diastase, precipitated by alcohol, but not dried before dissolving in water, is completely converted into maltose without the poduction of any intermediate product. The localisation of α-amylose and of amylopectin in starch granules can be demonstrated by an examination of sections after treatment with barley diastase at a suitable temperature, so that the α-amylose is dissolved away. Sections of granules have been cut of less thickness than 2μ, and a microscopical examination of these, after treatment with barley diastase, shows that the granules are made up of alternate layers of α-amylose and amylopectin. It would seem that the function of amylopectin is to protect the granules from the action of diastase of translocation which is present in various parts of a plant. This enzyme, which is probably identical with barley diastase, is incapable of saccharifying amylopectin. The latter is, however, dephosphated and depolymerised to αβ-hexa-amylose under the action of barley diastase.

The products of hydrolysis of amylopectin, or what amounts to the same thing of αβ-hexa-amylose, by malt diastase consist of a series of maltodextrins, a trisaccharide, *iso*maltose, maltose, and glucose, according to conditions. I will confine my remaining remarks to recent work I have carried out on the trisaccharide β-glucosidomaltose and *isomaltose*.

iso*Maltose*.—The existence of this sugar has so often been affirmed and denied that I feel it necessary to describe some recent experiments on the subject carried out in my department. In the first place, I may point out that the sugar has been wrongly confused with the so-called *iso*maltose obtained by Emil Fischer by the action of hydrochloric acid on glucose. This sugar is a reversion product, and it has been shown to consist to some extent of gentiobiose.

ON THE DURABILITY OF THE ALKALINE SOLUTION OF POTASSIUM FERRICYANIDE AS AN ETCHING REAGENT IN MICROSCOPY.

By Takejiro Murakimi and Kin'ichi Someya.

(Tohoku Imperial University Reports.)

Synopsis.

The alkaline solution of potassium ferricyanide which is constantly used in our Institute and also by many in foreign countries for etching steels containing chromium, tungsten, molybdenum, etc., is not very stable, but suffers from decomposition with the lapse of time. The present paper deals with the various features of this change, *i.e.*, the durability, the relation

between the rate of decomposition and the etching action, and that between the same rate and composition, and finally the mechanism of the photochemical decomposition. While the last-mentioned thing has not been made sufficiently clear, the experiment established what the best composition for obtaining the desired etching strength is, and also the fact that the durability is very great, the etching strength being found even to increase with decomposition during the period of 4 to 6 months after its preparation.

Introduction.

In his study of the alloys of the iron-carbon-chromium system one of the present writers (Murakami) investigated the suitability of various alkaline oxidising agents and found that the solution prepared by dissolving in 100 cc. of water gave good results. This reagent is also conveniently used in detecting various carbides appearing not only in chromium steels, but tungsten, high speed and molybdenum steels, and also the phosphide in steels and cast iron. The special advantage of this reagent, in which it differs from sodium picrate solution, is that its etching action is sufficiently rapid at ordinary temperatures, and it is consequently recommended for use in our Institute. The use of this reagent in microscopy seems also to be common in other countries, and frequent mention is made of it as Murakami's reagent. Its use is not limited to the ferrous alloys, but it is also applied in treating aluminium alloys. As an example of its use in the latter case may be cited the investigation by T. Ishihara, where this reagent was used with success in his microscopic examination.

This reagent is not very stable if left for a long time, decomposition and the consequent deposition of ferric hydroxide gradually taking place, and hence it seemed very desirable to make a more detailed study of the various features of this change, *i.e.*, its durability, the strength of its attack on the test specimen, the relation between the rate of decomposition and the etching action, with reference to the change in the concentration of the alkali and the ferricyanide.

Summary.

The etching actions of alkaline solutions of potassium ferricyanide of various concentrations on the carbide of a high speed steel was compared and the relation between the concentration of the reagent and the etching action, the change of the etching action with time and the mechanism of the decomposition of the reagent examined. The results may be summarised in the following words :—

1. The degree of etching action on the carbides of high speed steels changes along with the concentration of alkali and ferricyanide, it being stronger with a greater concentration. When the concentration of both solutes is above 5 per cent., a good etching is obtained in less than 20 minutes at room temperatures.

2. The reagent suffers decomposition with time, the decomposition being faster with a greater concentration of alkali.

3. The *decomposition of alkali takes* place rapidly at first and becomes assymp*totic with the lapse of time, while* that of ferricyanide is on the whole linear.

4. The reagent decomposes rapidly in direct sunlight, but very slowly in a diffused day-light, especially so when it is kept in a brown bottle.

5. The change in the etching efficacy as regards time, differs from that of the alkali or the ferricyanide in that for all concentrations it is greater after the lapse of a certain time than just after its preparation, and the strength then begins to decrease gradually.

6. When kept at a place in a room not exposed to direct *sun-light, the etching* action continues to increase for the first *4 to 6 months, after which it decreases* gradually. But even after one year, the etching strength of the reagent is not very different from that at the beginning of the test.

7. It was ascertained that in the decomposition the ferricyanide changes first, into the aquo-prussi salt, which is next reduced to the aquo-prusso salt and then this second salt changes into the ferrocyanide.

8. The probably formation in the course of the decomposition of an intermediate compound possessing a greater etching action than ferricyanide is indicated.

In conclusion the present writers wish to express their hearty thanks to Mr. K. Nakano for his enthusiastic help in their etching experiments and to Mr. T. Kato for his great help on the analysis.

MEASURING LAYERS OF ATOMS.

DESCRIBED TO INSTITUTE OF CHEMISTRY OF THE AMERICAN CHEMICAL SOCIETY.

A micrometer measuring the distance between layers of atoms in crystals is being used in X-ray studies which, it is asserted by chemists, promise to create a new sphere of knowledge in metals and profoundly influence industry.

" These distances are so small that it is hard to imagine them," says the announcement of the researches by the Institute of Chemistry recently founded by the American Chemical Society, and which at its first sessions at Pennsylvania State College in July, attracted hundreds of scientists at an international forum.

" The range from five to ten thousand-millionths of an inch, yet the new micrometer measures each spacing with such accuracy that the final answer is accurate to a hundred thousand-millionth part of an inch."

This is the sort of apparatus, contrived through the X-ray at the research laboratory of the General Electric Company, Schenectady, N.Y., which, according to the announcement, is being utilised in the studies, now under way at Penn State under the direction of Dr. W. P. Pavey, General Electric scientist, who has been appointed to direct Institute courses in X-rays and crystal structure. The studies, it is explained, are directed toward investigating the properties of metals and their alloys.

PREDICT PROPERTIES OF METALS.

" By measuring these minute distances," the Institute's announcement continues, " it is already possible to predict some of the mechanical properties of metals, and to tell what happens when they form alloys. It is possible to show why copper is more ductile than iron, and why iron is more ductile than arsenic.

" Similar measurements made on tungsten, the material of which lamp filaments are made, make it seem that the Coolidge process now in use is the only process by which it can be made into ductile wire.

" It is hoped that work of this sort continued over a term of years, will make it possible to write out a prescription for an alloy and heat treatment before the alloy is made.

" Perhaps this is a visionary goal, but at any rate it is no more visionary than an automobile was thirty years ago nor than airplanes were twenty years ago, or radio ten years ago.

Dr. Davey's work, A. W. Kenney, of the E. I. du Pont de Nemours & Co., executive secretary of the Institute of Chemistry, says, has only just begun.

" While extraordinary immediate results cannot be claimed, the investigators hope by studies which will take perhaps five to ten years," Mr. Kenney added, " to understand so clearly the arrangement of atoms of which alloys consist, the effects of these arrangements on the physical and electrical properties of the alloys, and the effect of the different methods of preparation on the arrangement of the atoms, that, whereas now the development of a new alloy to meet special conditions is an expensive tedious, and empirical process, it will, with the new knowledge, be simple and direct'

NEW METHOD OF METALLURGY.

" It will, in short, be the basis of an entirely new method in metallurgy with results so far-reaching that the scientist, with his cautious regard for truth, hesitates to predict what they will be."

Efforts are being made by many industries, the Institutes announcement says, to use X-rays to locate defects in their products just as X-rays are used by surgeons in setting broken bones and in diagnosing for ulcers and cancers.

In some cases the cost has proved too high, and the attempts have been abandoned. Experience has shown that the less dense the material to be inspected, the cheaper the method was, and the more likely it was to survive.

One shoe company, it is said, has developed an apparatus for examining every pair of shoes which it makes in order to make sure that no nails stuck through the shoes.

X-ray inspection of mica has been developed, it is stated, so that it is now cheap and rapid. " Such inspection," it is declared, " tends to insure the reliability of our electric power supply, and contributes to the safety of electric ship propulsion both for the ferry in the harbour and for the ocean liner."—*Chemicals.*

General Notes.

GARNET WHEAT IN CANADA.

The Dominion Department of Agriculture has just issued Buleltin No. 83, New Series, entitled "Garnet Wheat — New Promising Variety of Early Maturing Spring Wheat," by L. H. Newman and A. G. O. Whiteside.

Among the numerous new varieties of cereals originated and developed by the Cereal Division of the Dominion Experimental Farm, Ottawa, the variety of spring wheat known as Garnet is receiving the greatest attention at the present moment. Probably no variety within recent times has been more widely discussed or more extensively investigated, especially during the past year or two, than this variety. Like most new creations which appear particularly promising, Garnet has been given a reputation by certain enthusiastic journalists and others which it will find very difficult, if not impossible, to live up to. For instance, the claim has been made that this variety is rust resistant, which is not true. Others have stated that it may revolutionise wheat-growing over the whole of Western Canada. Such a statement obviously is quite premature and hardly probable. A true and unbiased statement of what actually is known regarding the performance and quality of Garnet in comparison with other varieties in widely scattered districts should be useful in indicating the place which this variety may be entitled to occupy among those now being propagated or under investigation.

NOVA SCOTIA SALT FOR USE IN THE FISHERIES.

In 1917 rock salt was discovered at Malagash, Nova Scotia, and the first production from this deposit was made two years later. The importance of this discovery to the fisheries of the Maritime provinces was early recognised and steps were taken to produce grades of salt suitable for the curing and packing of fish. The development of these deposits has progressed steadily from a production of 174 tons in 1919 to over 8,000 tons in 1926.

The salt from these deposits is won by mining, the salt being encountered at a depth of only 85 feet from the surface, after which it is crushed and ground into suitable grades.

In the preserving of fish for the markets, salt has long played an important part, but it is only within recent years that any systematic study of the effect of salt on the flesh of fish has been made. It has been found that salt produced by solar evaporation from sea water contained a certain bacterial organism which produced a red discolouration on the fish especially on cod fish but this organism is not present in salt produced from bedded salt deposits. The rate of penetration of salt into the tissues of the fish has also been extensively studied and the results have shown that the faster the penetration the better the quality of the product. The rate of penetration has been found to depend to a great extent on the purity of the salt; the purer the salt the faster the penetration. The presence in the salt of calcium and magnesium compounds is found to be highly detrimental.

CANADIAN COMPANY INSTALS LARGEST CALCIUM CARBIDE FURNACE ON AMERICAN CONTINENT.

The Canada Carbide Company Ltd., a wholly-owned subsidiary of the Shawinigan Water and Power Company, shortly will have the largest carbide furnace on the American Continent. The capacity will be approximately 50 per cent. greater than the present furnace. The new equipment will cost $250,000. The Canada Carbide Company is one of the largest power users of the group of electro-chemical industries located at Shawinigan Falls in close proximity to the power developments on the St. Maurice River. It has been utilising over 30,000 horsepower in the manufacture of calcium carbide, a large portion of which is converted into acetylene gas and sold to Canadian Electro Products Company, Ltd., another Shawinigan subsidiary, for manufacture into various chemicals. The latter company began business during the war to produce acetone, required by the munitions authorities. It now produces acetaldehyde, acetic acid and other chemicals which enjoy a world-wide market.

The installation of the new furnace by the Canada Carbide Company will no doubt mean the utilisation of an increased amount of Canada's cheap hydro-electric

power and the further development of Shawinigan Falls as one of the most important electro-chemical centres on the Continent.

X-RAYS AND THE CHEMICAL MOLECULE.

By Mr. George Shearer, M.A.

By the standard methods of chemistry is has been found possible, in many cases, to form a picture of the relative positions of the various atoms which combine to form the molecule. It is largely on the nature of this arrangement that the properties of the molecule depend. In the X-rays we have a new method of studying the problem of molecular structure, a method which should, eventually, enable us accurately to determine the size and shape of the molecule and the field of force around it. The X-rays method differs from the chemical method in that it deals with the molecule in the solid state, but there is much evidence to suggest that the differences between the molecule in solution and in the solid are small, so that the study of one should throw light on the other. By means of X-rays much may be learned as to the symmetry properties of molecules and the way in which they pack together to form the solid. There must be a close connection between the chemical reactivity of the molecule and the nature of this packing process since both are determined by the field of force around it. In a restricted way we may employ X-rays in the problems of chemical analysis, and, in cases where; the ordinary methods break down or are difficult of application, this new method should be of great help to the chemist. In the investigation of complicated molecules the X-rays may be used as a means of determining molecular weight, the state of the molecular association and the like.

PROCEEDINGS AND NOTICES OF SOCIETIES.

GEOLOGICAL SOCIETY OF LONDON.

The following paper was read on March 23, 1927, Dr. F. A. Bather, M.A., F.R.S., President, in the chair:—

The Stratigraphy and Geological Structure of the Cambrian Area of Comley (Shropshire). By Edgar Sterling Cobbold, F.G.S.

The object of this paper is to place on record the exact positions of the excavations made by the Author since 1906, and to describe the stratigraphy and tectonics as revealed by them and by the surface-features.

After a shortened historical account of research the Author gives an index-list of the excavations, references to their positions, to the appropriate Reports made to the British Association for the Advancement of Science, and to the faunal horizons seen at each spot. Notes upon some recent excavations and field-work are appended.

Under the heading of stratigraphy, he discusses the sequence and general lithographical characters of the horizons as previously defined, Q.J.G.S. vol. lxxvi (1920) p. 326.

Under the heading of tectonics, evidence is adduced to show that the folding and faulting of the Cambrian fall naturally into four groups: (1) post-Mesonacidian and pre Paradoxidean, general direction unknown; (2) post-Paradoxidean and pre-Caradocian, general direction north-north-west to south-south-east; (3) post-Caradocian and pre-Silurian, general direction north-east to south-west, all the result of compressive forces; and (4) post-Silurian, tensional stresses responsible for the Church Stretton Fault. Certain faults affecting the Cambrian are traced up to the Caradocian, but do not affect its outcrop; others affect the Cambrian profoundly, but show slight signs of posthumous movement in post-Ordovician times; and yet others are seen which are regarded as due to the post-Silurian tension.

The facts detailed in the paper enable us to form a fairly consecutive series of views of the deposition and deformation of the Comley Cambridge deposits. These are briefly summarised under fourteen or fifteen headings, and indicate seven diastrophic phases of various intensities. As Prof. Charles Lapworth once said of the bottom of the Cambrian Sea, 'it kept coming up again.'

Special attention is given to the complicated Dairy Hill portion of the area, where recent study and some fresh excavation in 1926 have fully substantiated the inference previously drawn from the Comley Breccia-Bed, that a peak or promontory of Lower Cambrian sandstone remained above water during the accumulations of some 800 feet or more of strata of the *Paradoxides-groomi* Zone.

The paper is illustrated by a geological map of the area on the 6-inch scale, a reproduction of the Dairy Hill portion on the 25-inch scale, an ideal section of the *Paradoxides* Beds while still horizontal, and a sheet of six parallel sections across the area.

A discussion followed.

THE INSTITUTE OF METALS.

Autumn Meeting, Derby, September 6 to 9, 1927.

The Autumn Meeting of the Institute will be held at Derby Municipal Technical College, from September 6 to 9, under the kind direction of Sir Henry Fowler, K.B.E., LL.D., Vice-President, and with the assistance of Mr. G. W. Woolliscroft, Wh.Sc., M.I.Mech.E., who has been good enough to undertake to act as the Honorary Local Secretary of the Meeting.

Tuesday, September 6, at 8p.m.—Sixth Autumn Lecture, by Dr. L. Aitchison, B.Sc., F.I.C., on " Non-Ferrous Metals in Modern Transport," in the Municipal Technical College.

Thursday, September 8, at 10 a.m.—General Meeting of Members in the Municipal Technical College. A selection of papers will be presented in abstract and discussed as time permits.

On September 7 there will be a reception by the Mayor at the Art Gallery, 8 to 10 p.m. There will be visits to various local works, smoking concerts, an all-day excursion to the Peak District on Friday, September 9.

U.S.A. INSECTICIDE AND FUNGICIDE BOARD.

Selected Judgments Under Section 4 of the Insecticide Act, 1910.

1076.—Adulteration and misbranding of " Kellogg's Ant Paste." U.S. v. Johnson, Carvell & Murphy. Plea of Guilty. Fine, $75.

On November 19, 1926, the United States attorney for the Southern District of California, acting upon a report by the Secretary of Agriculture, filed in the district court of the United States for said district an information against Johnson, Carvell & Murphy, a corporation, Los Angeles, Calif., alleging shipment by said company, in violation of the Insecticide Act of 1910, on or about June 10, 1924, from the State of California into the State of Washington, of a quantity of "Kellogg's Ant Paste," which was an adulterated and misbranded insecticide within the meaning of said Act.

Defendants pleaded guilty and were fined $75.

1078.—Misbranding of " Thompson's Bollweevil Eradicator." U.S. v. Thompson Chemical Co. Plea of guilty. Fine and costs, $10.

On July 31, 1923, the United States attorney for the Middle District of Tennessee, acting upon a report by the Secretary of Agriculture, filed in the district court of the United States for said district an information against the Thompson Chemical Co., a corporation, trading at Nashville, Tenn., alleging shipment by said company, in violation of the Insecticide Act of 1910, on or about March 6, 1922, from the State of Tennesse into the State of Louisiana, of a quantity of " Thompson's Bollweevil Eradicator," which was a misbranded insecticide within the meaning of said Act.

A plea of guilty was entered.—Penalty, $10.

1079. — Misbranding of " Penn-ola." U.S. v. John N. Wittpenn, sr., and John N. Wittpenn, jr. (Rockland Chemical Co.) Pleas of guilty. Fines $10.

On October 1, 1926, the United States attorney for the district of New Jersey, acting upon a report by the Secretary of Agriculture, filed in the district court of the United States for said district an information against John N. Wittpenn, sr., and John N. Wittpenn, jr., trading as a partnership at Newark, N.J., as the Rockland Chemical Co., alleging shipment by said defendants, in violation of the Insecticide Act of 1910, on or about April 20, 1925, from the State of New Jersey into the State of New York, of a quantity of " Penn-ola," which was a misbranded insecticide and fungicide within the meaning of said Act.

Pleas of guilty—Fines $5 each.

1081. — Misbranding of " Pet-Sope." U.S. v. World Chemical Co. Collateral of $200 forfeited.

On November 24, 1926, the United States Attorney for the District of Columbia, acting upon a report by the Secretary

of Agriculture, filed in the police court of the District aforesaid, an information against the World Chemical Co., a corporation, trading at Washington, D.C., alleging that on or about June 16, 1925, the said company did sell in the District of Columbia a quantity of "Pet-Sope," which was a misbranded insecticide and fungicide within the meaning of the Insecticide Act of 1910.

No appearance and $200 collateral deposited as security for appearance was forfeited.

1082.—Misbranding of "Lime Sulphur Solution." U.S. v. Wescott, Slade and Balsolm Co. Plea of guilty. Fine, $20.

On September 3, 1926, the United States attorney for the district of Rhode Island, acting upon a report by the Secretary of Agriculture, filed in the district court of the United States for said district an information against Wescott, Slade and Balcom Co., a corporation, Providence, R.I., alleging shipment by said company, in violation of the Insecticide Act of 1910, in two consignments, on or about February 17 and June 27, 1925, respectively, from the State of Rhode Island into the State of Massachusetts, of quantities of "Lime Sulphur Solution," which was a misbranded insecticide and fungicide within the meaning of said Act.

Plea of guilty.—Fine of $20.

1085.—Adulteration and misbranding of "Agramid Phenyle Disinfectant." U.S. v. Agramid Products Co. Plea of guilty. Fine, $100.

On July 26, 1926, the United States attorney for the Eastern District of New York, acting upon a report by the Secretary of Agriculture, filed in the district court of the United States for said district an information against the Agrimid Products Co., a corporation, College Point, N.Y., alleging shipment by said company, in violation of the Insecticide Act of 1910, on or about June 27, 1925, from the State of New York into the State of Connecticut, of a quantity of "Agrimid Phenyle Disinectant, which was an adulterated and misbranded insecticide and fungicide.

Plea of guilty.—Fine, $100.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

20,490.—Adams, H.—Manufacture of products from lignin sulphonic acid. August 3rd.

20,573.—Flesch, H.—Production of sulphonated oils, etc. August 4th.

20,522.—Gareau, N. J. Production of alumina, soda, and hydrochloric acid. August 3rd.

20,432.—Gulker, F. — Production of hydrogen. August 2nd.

20,582.—Soc. of Chemical Industry in Basle.—Manufacture of azo dyestuffs. August 4th.

Specifications Published.

264,148.—Canadian Electro Products Co., Ltd.—Manufacture of hydroxy acid esters.

269,908.—Urbain Corporation. — Process for the recovery of phosphorus and hydrogenated compounds thereof in the form of phosphoric acid.

Abstract Published.

272,919.—Solubilising alcohols; treating textiles.—Bohme Akt.-Ges., H. T., 29, Moritzstrasse, and Bertsch, H., both in Chemnitz, Germany.

Stable aqueous dispersions or solutions of higher alcohols, *i.e.*, alcohols containing four or more carbon atoms, are obtained with the use as dispersing agents of the products obtained by sulphonating a fat or a fatty acid in the presence of an aliphatic acid, acid anhydride, —or acid chloride. A suitable dispersing agent is prepared by sulphonating fatty acid from castor oil in the presence of butyric acid at a tempera-

ture below zero, and washing and neutralising the product; instead of butyric acid, its anhydride, or propionyl chloride, may be used. Suitable proportions are given for the *preparation of solutions of* (1) butyl alcohol, and (2) amyl alcohol and cyclohexanol, and reference is made also to *the treatment of hydronaphthols.* The dispersions or solutions are of use in the treatment of textile materials, and may be *added, for example, to vat-dyeing baths* and to the baths employed in mercerising cotton goods and in carbonising wool.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official *Trade Marks Journal*, and is *Published* by permission of the Controller of His Majesty's Stationery Office.

MITHAYRION.

479,657.—Chemical substances used in Manufactures, photography, or philosophical research, and anti-corrosives.—Ernest Sverard Gates, Old Buckenham Hall, Old Buckenham, near Norwich, Norfolk. August 10th.

OXALBA.

477,515.—Chemical substances in Class 1, for use in the manufacture of enamel goods.—J. G. Gregory and Sons, 10, Penkhull Street, Newcastle-under Lyme, Staffordshire. August 10th.

LANSOLAC.

482,197.—Chemical substances prepared for use in medicine and pharmacy. —Roberts & Co., 76, New Bond Street, London, W.1. August 10th.

NEPTAL.

482,137.—Chemical substances prepared for use in *medicine and pharmacy.* —Les Etablissements Poulenc Freres, 86 to 92, Rue Vieille-du-Temple, Paris, France. August 10th.

GEN. INDEX TO THE "CHEMICAL NEWS"—VOLS. 1 TO 100.

This large volume contains a detailed Index to the first 100 volumes of the *Chemical News*, and will be found of great value to all interested in Chemical, Engineering, Electrical, and General Scientific subjects. It has been compiled with great care, is handsomely bound in red cloth, and has been produced at great expenditure of time, labour and money. Carriage paid, Great Britain, 21/- net; Carriage paid to Foreign Countries and the Colonies, 28/- net.

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THE CHEMICAL NEWS

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BRITISH ASSOCIATION for the Advancement of Science.

LEEDS (AUGUST 31—SEPTEMBER 7), 1927.

THE PRESIDENTIAL ADDRESS, DELIVERED ON AUGUST 31, 1927.

Darwin's Theory of Man's Descent as it Stands To-day.

By PROF. SIR ARTHUR KEITH.

"MY LORD MAYOR, MR. VICE-CHANCELLOR, LADIES AND GENTLEMEN,

My first duty as your President, and it is a very pleasant one, is to send the following message in your name to H.R.H. The Prince of Wales:—

'YOUR ROYAL HIGHNESS,

The British Association for the Advancement of Science, now assembled in Leeds to begin another session, cannot allow your year of office to terminate without offering to you sincere and humble congratulations on the happy results which have attended your Presidency. A year ago, in the historic city of Oxford, you did British Science the signal honour of coming among us as our President; the meeting you then inaugurated set a standard which future gatherings will strive to emulate. The inspiring message you then addressed to us, and through us to men of science in every part of the Empire has already borne fruit. We are within sight of a closer union, for which the Association itself has always striven, between men of overseas and their colleagues at home, in their endeavour to solve problems of Imperial concern. It is too soon as yet to assess the value of the harvest of science planted under your ægis, for the best vintages of science mature slowly, but of this we are certain: the interest your Royal Highness has taken in the work of this Association will prove a permanent source of encouragement for all who work for the betterment of life through increase of knowledge. To-night we proudly add your Presidential banner to those of the great men of science who have presided over this Association since its inception at York ninety-six years ago.'

SUBJECT OF ADDRESS.

In olden times men kept their calendars by naming each year according to its outstanding event. I have no doubt that in future times the historian of this Association, when he comes to distinguish the Pre-

sidential year which opened so auspiciously in Oxford twelve months ago, will be moved to revert to this ancient custom and name it the Prince's Year. And I am under no misapprehension as to what will happen when our historian comes to the term which I have now the honour of inaugurating at Leeds; he will immediately relapse to the normal system of numerical notation. Nor will our historian fail to note, should he be moved to contrast the Meeting at Oxford with that which now begins at Leeds, that some mischievous sprite seems to have tampered with the affairs of this Association. For how otherwise could he explain the fortune which fell to ancient Oxford, the home of History? To her lot fell a brilliant discourse on the application o fscience to the betterment of human lives, while Leeds, a city whose life's blood depends on the successful application of Science to Industry, had to endure, as best she could, a discourse on a theme of ancient history. For the subject of my address is Man's remote history. Fifty-five years have come and gone since Charles Darwin wrote a history of Man's Descent. How does his work stand the test of time? This is the question I propose to discuss with you to-night in the brief hour at my disposal.

The Opening Shot in the Darwinian Battle.

In tracing the course of events which led up to our present conception of Man's origin, no place could serve as a historical starting-point so well as Leeds. In this city was fired the first verbal shot of that long and bitter strife which ended in the overthrow of those who defended the Biblical account of Man's creation and in a victory for Darwin. On September 24, 1858 --sixty-nine years ago—the British Association assembled in this city just as we do to-night; Sir Richard Owen, the first anatomist of his age, stood where I now stand. He had prepared a long address, four times the length of the one I propose to read, and surveyed, as he was well qualified to do, the whole realm of Science; but only those parts which concern Man's origin require our attention now. He cited evidence which suggested a much earlier date for the appearance of man on earth than was sanctioned by Biblical records, but poured scorn on the idea that man was merely a transmuted ape. He declared to the assembled Association that the differences between man and ape were so great that it was necessary, in his opinion, to assign mankind to an altogether separate Order in the Animal Kingdom. As this statement fell from the President's lips there was at least one man in the audience whose spirit of opposition was roused—Thomas Henry Huxley—Owen's young and rising antagonist.

Owen and Huxley.

I have picked out Huxley from the audience because it is necessary, for the development of my theme, that we should give him our attention for a moment. We know what Huxley's feelings were towards Owen at the date of the Leeds Meeting. Six months before he had told his sister that 'an internecine feud rages between Owen and myself,' and on the eve of his departure for Leeds he wrote to Hooker: 'The question arises: shall I have a row with the great O. there-' I am glad to say the Leeds Meeting passed off amicably, but it settled in Huxley's mind what the 'row' was to be about when it came. It was to concern Man's rightful position in the scale of living things.

Man's Position in the Animal Kingdom.

Two years later, in 1860, when this Association met in Oxford, Owen gave Huxley the opportunity he desired. In the course of a discussion Owen repeated the statement made at Leeds as to Man's separate position, claiming that the human brain had certain structural features never seen in the brain of anthrapoid apes. Huxley's reply was a brief and emphatic denial with a promise to produce evidence in due course—which was faithfully kept. This opening passage at arms between our protagonists was followed two days later by that spectacular fight—the most memorable in the history of our Association—in which the Bishop of Oxford, the representative of Owen and of Orthodoxy, left his scalp in Huxley's hands. To make his victory decisive and abiding, Huxley published, early in 1863, 'The Evidence of Man's Place in Nature,' a book which has a very direct bearing on the subject of my discourse. It settled for all time that Man's rightful position is among the Primates, and that as we anatomists weigh evidence, his nearest living kin are the anthropoid apes.

Owen's Opinion of Darwinism.

My aim is to make clear to you the foundations on which rest our present-day conception of Man's origin. The address delivered by my predecessor from this chair at the Leeds Meeting of 1858 has given me the opportunity of placing Huxley's fundamen-

tal conception of Man's nature in a historical setting. I must now turn to another issue which Sir Richard Owen merely touched upon but which is of supreme interest to us now. He spent the summer in London, just as I have done, writing his address for Leeds and keeping an eye on what was happenning at scientific meetings. In his case something really interesting happened. Sir Charles Lyell and Sir Joseph Hooker left with the Linnean Society what appeared to be an ordinary roll of manuscript, but what in reality was a parcel charged with high explosives, prepared by two very innocent-looking men—Alfred Russel Wallace and Charles Darwin. As a matter of honesty it must be admitted that these two men were well aware of the deadly nature of its contents, and knew that if an explosion occurred, Man himself, the crown of creation, could not escape its destructive effects. Owen examined the contents of the parcel and came to the conclusion that they were not dangerous; at least, he manifested no sign of alarm in his Presidential Address. He dismissed both Wallace and Darwin, particularly Darwin, in the briefest of paragraphs, at the same time citing passages from his own work to prove that the conaception of Natural Selection as an evolutionary force was one which he had already recognised.

The Transformation of Our Outlook on Man's Origin.

As I address these words to you I cannot help marvelling over the difference between our outlook to-day and that of the audience which Sir Richard Owen had to face in this city sixty-nine years ago. The vast assemblage which confronted him was convinced, almost without a dissentient, that Man had appeared on earth by a special act of creation; whereas the audience which I have now the honour of addressing, and that larger congregation which the wonders of wireless bring within the reach of my voice, if not convinced Darwinists are yet prepared to believe, when full proofs are forthcoming that Man began his career as a humble primate animal, and has reached his present estate by the action and reaction of biological forces which have been and are ever at work within his body and brain.

Darwin's Generalship.

This transformation of outlook on Man's origin is one of the marvels of the nineteenth century, and to see how it was effected we must turn out attention for a little while to the village of Down in the Kentish uplands and note what Charles Darwin was doing on the very day that Sir Richard Owen was delivering his address here in Leeds. He sat in his study struggling with the first chapter of a new book: but no one foresaw, Owen least of all, that the publication of the completed book, *The Origin of Species*, fifteen months later (1859), was to effect a sweeping revolution in our way of looking at living things and to initiate a new period in human thought—the Darwinian Period—in which we still are. Without knowing it, Darwin was a consummate general. He did not launch his first campaign until he had spent twenty-two years in stocking his arsenal with ample stores of tested and assorted facts. Having won territory with *The Origin of Species*, he immediately set to work to consolidate his gains by the publication in 1868 of another book, *The Variation of Animals and Plants under Domestication*—a great and valuable treasury of biological observation. Having thus established an advanced base, he moved forwards on his final objective—the problem of Human Beings—by the publication of *The Descent of Man* (1871), and that citadel capitulated to him. To make victory doubly certain he issued in the following year—1872—*The Expression of the Emotions in Man and Animals*. Many a soldier of truth had attempted this citadel before Darwin's day, but they failed because they had neither his generalship nor his artillery.

History as Written by Darwin.

Will Darwin's victory endure for all time? Before attempting to answer this question, let us look at what kind of book *The Descent of Man* is. It is a book of history—the history of Man, written in a new way—the way discovered by Charles Darwin. Permit me to illustrate the Darwinian way of writing history. If a history of the modern bicycle had to be written in the orthodox way, then we should search dated records until every stage was found which linked the two-wheeled hobby-horse, bestrode by tall-hatted fasionable men at the beginning of the nineteenth century, to the modern 'jeopardy' which now flashes past us in country lanes. But suppose there were no dated records—only a jumble of antiquated machines stored in the cellar of a museum. We should, in this case, have to adopt Darwin's way of writing history. By an exact and systematic comparison of one machine with another we could infer the relationship of one to another and tell the order of their appearance, but as to the date

at which each type appeared and the length of time it remained in fashion, we could say very little. It was by adopting this circumstantial method that Darwin succeeded in writing the history of Man. He gathered historical documents from the body and behaviour of Man and compared them with observations made on the body and behaviou of every animal which showed the least resemblance to Man. He studied all that was known in his day of Man's embryological history and noted resemblances and differences in the corresponding histories of other animals. He took into consideration the manner in which the living tissues of Man react to disease, to drugs, and to environment; he had to account for the existence of diverse races of mankind. By a logical analysis of his facts Darwin reconstructed and wrote a history of Man.

Darwin's Position has Become Impregnable.

Fifty-six years have come and gone since that history was written; an enormous body of new evidence has poured in upon us. We are now able to fill in many pages which Darwin had perforce to leave blank, and we have found it necessary to alter details in his narrative, but the fundamentals of Darwin's outline of Man's History remain unshaken. Nay, so strong has his position become that I am convinced that it never can be shaken.

The Evidence of Fossil Remains.

Why do I say so confidently that Darwin's position has become impregnable? It is because of what has happened since his death in 1882. Since then we have succeeded in tracing Man by means of his fossil remains and by his stone implements backwards in time to the very beginning of that period of the earth's history to which the name Pleistocene is given. We thus reach a point in history which is distant from us at least 200,000 years, perhaps three times that amount. Nay, we have gone farther, and traced him into the older and longer period which preceded the Pleistocene—the Pliocene. It was in strata laid down by a stream in Java during the latter part of the Pliocene period that Dr. Eugene Dubois found, ten years after Darwin's death, the fossil remains of that remarkable representative of primitive humanity to which he gave the name *Pithecanthropus*, or Ape-Man; from Pliocene deposits of East Anglia, Mr. Reid Moir has recovered rude stone implements. If Darwin was right, then as we trace Man backwards in the scale of time he should become more bestial in form—nearer to the ape. That is what we have found. But if we regard *Pithecanthropus* with his small and simple yet human brain as a fair representative of the men of the Pliocene period, then evolution must have proceeded at an unexpectedly rapid rate to culminate to-day in the higher races of Mankind.

Man's Descent Has Not Been in a Straight Line.

The evidence of Man's evolution from an ape-like being, obtained from a study of fossil remains, is definite and irrefutable, but the process has been infinitely more complex than was suspected in Darwin's time. Our older and discarded conception of Man's transformation was depicted in that well-known diagrom which showed a single file of skeletons, the gibbon at one end and Man at the other. In our original simplicity we expected, as we traced Man backwards in time, that we should encounter a graded series of fossil forms—a series which would carry him in a straight line towards an anthropoid ancestor. We should never have made this initial mistake if we had remembered that the guide to the world of the past is the world of the present. In our time Man is represented not by one but by many and diverse races—black, brown, yellow, and white; some of these are rapidly expanding, others are as rapidly disappearing. Our searches have shown that in remote times the world was peopled, sparsely it is true, with races showing even a greater diversity than those of to-day, and that already the same process of replacement was at work. To unravel Man's pedigree, we have to thread our way, not along the links of a chain, but through the meshes of a complicated network.

The Diversity of Form in Ancient Times.

We made another mistake. Seeing that in our search for Man's ancestry we expected to reach an age when the beings we should have to deal with would be simian rather than human, we ought to have marked the conditions which prevail amongst living anthropoid apes. We ought to have been prepared to find, as we approached a distant point in the geological horizon, that the forms encountered would be as widely different as are the gorilla, chimpanzee and orang, and confined, as these great anthropoids now are, to limited parts of the earth's surface. That is what we are now realising; as we go backwards

in time we discover that mankind becomes broken up, not into separate races as in the world of to-day, but into numerous and separate species. When we go into a still more remote past they become so unlike that we have to regard them not as belonging to separate species but different genera. It is amongst this welter of extinct fossil forms which strew the ancient world that we have to trace the zigzag line of Man's descent. Do you wonder we sometimes falter and follow false clues?

Discordant Evolution.

We committed a still further blunder when we set out on the search for Man's ancestry; indeed ,some of us are still making it. We expected that Man's evolution would pursue not only an orderly file of stages, but that every part of his body—skull, brain, jaws, teeth, skin, body, arms, and legs—would at each stage become a little less ape-like, a little more Man-like. Our searches have shown us that Man's evolution has not proceeded in this orderly manner. In some extinct races, while one part of the body has moved forwards another part has lagged behind. Let me illustrate this point because it is important. We now know that, as Darwin sat in his study at Down, there lay hidden at Piltdown, in Sussex, not thirty miles distant from him, sealed up in a bed of gravel, a fossil human skull and jaw. In 1912, thirty years after Darwin's death, Mr. Charles Dawson discovered this skull and my friend Sir Arthur Smith Woodward described it, and rightly recognised that skull and jaw were parts of the same individual, and that this individual had lived, as was determined by geological and other evidence, in the opening phase of the Pleistocene period. We may confidently presume that this individual was representative of the people who inhabited England at this remote date. The skull, although deeply mineralised and thick-walled, might well have been the rude forerunner of a modern skull, but the lower jaw was so ape-like that some experts denied that it went with the human fossil skull at all, and supposed it to be the lower jaw of some extinct kind of chimpanzee. This mistake would never have been made if those concerned had studied the comparative anatomy of anthrapoid apes. Such a study would have prepared them to meet with the discordances of evolution. The same irregularity in the progression of parts is evident in the anatomy of *Pithecanthropus*, the oldest and most primitive form of humanity so far discovered. The thigh-bone might easily be that of modern man, the skull-cap that of an ape, but the brain within that cap, as we now know, had passed well beyond an anthropoid status. If merely a lower jaw had been found at Piltdown an ancient Englishman would have been wrongly labelled 'Higher anthropoid ape'; if only the thigh-bone of *Pithecanthropus* had come to light in Java, then an ancient Javanese, almost deserving the title of anthropoid, would have passed muster as a man.

Blanks Still Remain in the Geological Record.

Such examples illustrate the difficulties and dangers which beset the task of unravelling Man's ancestry. There are other difficulties; there still remain great blanks in the geological record of Man's evolution. As our search proceeds these blanks will be filled in, but in the meantime let us note their nature and their extent. By the discovery of fossil remains we have followed Man backwards to the close of the Pliocene—a period which endured at least for a quarter of a million years, but we have not yet succeeded in tracing him through this period. It is true that we have found fossil teeth in Pliocene deposits which may be those of an ape-like man or of a man-like ape; until we find other parts of their bodies we cannot decide. When we pass into the still older Miocene period—one which was certainly twice as long as the Pliocene—we are in the heyday of anthropoid history. Thanks to the labours of Dr. Guy E. Pilgrim, of the Indian Geological Survey, we know already of a dozen different kinds of great anthropoids which lived in Himalayan jungles during middle and later Miocene times; we know of at least three other kinds of great anthropoids which lived in the contemporary jungles of Europe. Unfortunately we have found as yet only the most resistant parts of their bodies—teeth and fragments of jaw. Do some of these fragments represent a human ancestor? We cannot decide until a lucky chance brings to light a limb-bone or a piece of skull, but no one can compare the teeth of these Miocene anthropoids with those of primitive man, as has been done so thoroughly by Prof. William K. Gregory, and escape the conviction that in the dentitions of the extinct anthropoids of the Miocene jungles we have the ancestral forms of human teeth.

Date of Man's Emergence.

Iit is useless to go to strata still older than the Miocene in search of Man's emergence; in such strata we have found only fossil traces of emerging anthropoids. All the evidence now at our disposal supports the conclusion that Man has arisen as Lamarck and Darwin suspected, from an anthropoid ape not higher in the zoological scale than a chimpanzee, and that the date at which human and anthropoid lines of descent to diverge lies near the beginning of the Miocene period. On our modest scale of reckoning, that gives Man the respectable antiquity of about one million years.

Proofs of our Anthrhopoid Antiquity.

Our geological search, which I have summarised all too briefly, has not produced so far the final and conclusive evidence of Man's anthropoid origin; we have not found as yet the human *imago* emerging from its anthropoid encasement. Why, then, do modern anthropologists share the conviction that there has been an anthropoid stage in our ancestry? They are no more blind than you are to the degree of difference which separates man and ape in structure, in appearance, and in behaviour. I must touch on the sources of this conviction only in a passing manner. Early in the present century, Prof. G. H. . Nuttall, of Cambridge University, discovered a trustworthy and exact method of determining the affinity of one species of animal to another by comparing the reactions of their blood. He found that the blood of Man and that of the great anthropoid apes gave almost the same reaction. Bacteriologists find that the living anthropoid body possesses almost the same susceptibilities to infections, and manifests the same reactions, as does the body of Man. So alike are the brains of Man and anthropid in their structural organisation that surgeons and physiologists transfer experimental observations from the one to the other. When the human embryo establishes itself in the womb it throws out structures of a most complex nature to effect a connection with the maternal body. We now know that exactly the same elaborate processes occur in the anthropoid womb and in no other. We find the same vestigial structures—the same 'evolutionary postmarks'—in the bodies of Man and anthropoid. The anthropoid mother fondles, nurses and suckles her young in the human manner. This is but a tithe of the striking and intimate points in which Man resembles the anthropoid ape. In what other way can such a myriad of coincidences be explained except by presumiug a common ancestry for both?

The Evolution of Man's Brain.

The crucial chapters in Darwin's *Descent of Man* are those in which he seeks to give a historical account of the rise of Man's brain and of the varied functions which that organ subserves. How do these chapters stand to-day? Darwin was not a professional anatomist and therefore accepted Huxley's statement that there was no structure in the human brain that was not already present in that of the anthropoid. In Huxley's opinion the human brain was but a richly annotated edition of the simpler and older anthropoid book and that this edition, in turn, was but the expanded issue of the still older original primate publication. Since this statement was made thousands of anatomists and physiologists have studied and compared the brain of Man and ape; only a few months ago Prof. G. Elliot Smith summarised the result of this intensive enquiry as follows: 'No structure found in the brain of an ape is lacking in the human brain, and, on the other hand, the human brain reveals no formation *of any sort* that is not present in the brain of the gorilla or chimpanzee. . . The only distinctive feature of the human brain is a quantitative one.' The difference is only quantitative, but its importance cannot be exaggerated. In the anthropoid brain are to be recognised all those parts which have become so enormous in the human brain. It is the expansion of just those parts which have given Man his powers of feeling, understanding ,acting, speaking and learning.

Darwin himself approached this problem not as an anatomist but as a psychologist, and after many years of painstaking and exact observation, succeeded in convincing himself that, immeasurable as are the differences between the mentality of Man and ape, they are of degree, not of kind. Prolonged researches made by modern psychologists have but verified and extended Darwin's conclusions. No matter what line of evidence we select to follow—evidence gathered by anatomists, by embryologists, by physiologists, or by psychologists—we reach the conviction that Man's brain has been evolved from that of an anthropoid ape and that in the process no new structure has been introduced and no new or strange faculty interpolated.

Unexplained Problems.

In these days our knowledge of the elaborate architecture and delicate machinery of the human brain makes rapid progress, but I should mislead if I suggested that finality is in sight. Far from it; our enquiries are but begun. There is so much we do not yet understand. Will the day ever come when we can explain why the brain of man has made such great progress while that of his cousin the gorilla has fallen so far behind? Can we explain why inherited ability falls to one family and not to another, or why, in the matter of cerebral endowment, one race of mankind has fared so much better than another? We have as yet no explanation to offer, but an observation made twenty years ago by one on whom Nature has showered great gifts—a former President of this Association and the doyen of British zoologists—Sir E. Ray Lankester—deserves quotation in this connection: 'The leading feature in the development and separation of Man from other animals is undoubtedly the relative enormous size of the brain in Man and the corresponding increase in its activities and capacity. It is a striking fact that it was not in the ancestors of Man alone that this increase in the size of the brain took place at this same period—the Miocene. Other great mammals of the early Tertian period were in the same case.' When primates made their first appearance in geological records, they were, one and all, small-brained. We have to recognise that the tendency to increase of brain, which culminated in the production of the human organ, was not confined to Man's ancestry but appeared in diverse branches of the Mammalian stock at a corresponding period of the earth's history.

Darwin's Conception of Evolution Illustrated.

I have spoken of Darwin as a historian. To describe events and to give the order of their occurrence is the easier part of a historian's task; his real difficulties begin when he seeks to interpret the happening of history, to detect the causes which produced them, and explain why one event follows as a direct sequel to another. Up to this point we have been considering only the material's for Man's history, and placing them, so far as our scanty information allows, in the order of their sequence, but now we have to seek out the biological processes and controlling influences which have shaped the evolutionary histories of Man and ape. The evolution of new types of Man or of ape is one thing, and the evolution of new types of motor cars is another, yet for the purposes of clear thinking it will repay us to use the one example to illustrate the other. In the evolution of motor vehicles Darwin's law of Selection has prevailed; there has been severe competition and the types which have answered best to the needs and tastes of the public have survived. The public has selected on two grounds—first, for utility, thus illustrating Darwin's law of Natural Selection; and secondly because of appearance's sake; for, as most people know, a new car has to satisfy not only the utilitarian demands of its prospective master but also the æsthetic tastes of its prospective mistress, therein illustrating Darwin's second law—the law of Sexual Selection. That selection, both utilitarian and æsthetic, is producing an effect on modern races of mankind and in surviving kinds of ape, as Darwin supposed, cannot well be questioned. In recent centuries the inter-racial competition amongst men for the arable lands of the world is keener than in any known period of human history.

The Production of New Types.

The public has selected its favoured types of car, but it has had no direct hand in designing and producing modifications and improvements which have appeared year after year. To understand how such modifications are produced the enquirer must enter a factory and not only watch artisans shaping and fitting parts together but also visit the designer's office. In this way an enquirer will obtain a glimpse of the machinery concerned in the evolution of motor cars. If we are to understand the machinery which underlies the evolution of Man and of ape, we have to enter the 'factories' where they are produced—look within the womb and see the ovum being transformed into an embryo, the embryo into a fœtus, and the fœtus into a babe. After birth, we may note infancy passing into childhood, childhood into adolescence, adolescence into maturity, and maturity into old age. Merely to register the stages of change is not enough; to understand the controlling machinery we have to search out and uncover the processes which are at work within developing and growing things and the influences which co-ordinate and control all the processes of development and of growth. When we have discovered the machinery of development and of growth we shall also know the machinery of Evolution for they are the same.

Machine and Animal Evolution.

If the simile I have used would sound strange in Darwin's ear, could he hear it, the underlying meaning would be familiar to him. Over and over again he declared that he did not know how 'variations' were produced, favourable or otherwise; nor could he have known, for in his time hormones were undreamt of and experimental embryology scarcely born. With these recent discoveries new vistas opened up for students of Evolution. The moment we begin to work out the simile I have used and compare the evolutionary machinery in a motor factory with that which regulates the development of an embryo within the womb, we realise how different the two processes are. Let us imagine for a moment what changes would be necessary were we to introduce 'embryological processes' into a car factory. We have to conceive a workshop teeming with clustering swarms of microscopic artisans, mere specks of living matter. In one end of this factory we find swarms busy with cylinders, and as we pass along we note that every part of a car is in process of manufacture, each part being the business of a particular brigade of microscopic workmen. There is no apprenticeship in this factory, every employee is born, just as a hive-bee is, with his skill already fully developed. No plans or patterns are supplied; every workman has the needed edsign in his head from birth. There is neither manager, overseer, nor foreman to direct and co-ordinate the activities of the vast armies. And yet if parts are to fit when assembled, if pinions are to mesh and engines to run smoothly, there must be some method of co-ordination. It has to be a method plastic enough to permit the introduction of advantageous modifications when these are needed. A modern works manager would be hard put to were he asked to devise an automatic system of control for such a factory, yet it is just such a system that we are now obtaining glimpses of in the living workshops of Nature.

The Machinery of Development.

I have employed a crude simile to give the lay mind an inkling of what happens in that 'factory' where the most complicated of machines are forged—the human body and brain. The fertilised ovum divides and redivides; one brood of microscopic living units succeeds another, and as each is produced the units group themselves to form the 'parts' of an embryo. Each 'part' is a living society; the embryo is a huge congeries of interdependent societies. How are their respective needs regulated, their freedoms protected, and their manœuvres timed? Experimental embryologists have begun to explore and discover the machinery of regulation. We know enough to realise that it will take many generations of investigators to work over the great and new field which is thus opening up. When this is done we shall be in a better position to discuss the cause of 'variation' and the machinery of Evolution.

The Machinery of Growth.

If we know only a little concerning the system of government which prevails in the developing embryo we can claim that the system which prevails in the growing body, as it passes from infancy to maturity is becoming better known to us every year. The influence of the sex glands on the growth of the body has been known since ancient times; their removal in youth leads to a transformation in the growth of every part of the body, altering at the same time the reactions and temperament of the brain. In more recent years medical men have observed that characteristic alterations in the appearance and constitution of the human body can be produced by the action of other glands—the pituitary, thyroid, parathyroid, and adrenals. Under the disorderly action of one or other of these glands individuals may, in the course of a few years, take on so changed an appearance that the differences between them and their fellows become as great as, or even greater than, those which separate one race of mankind from another. The physical characters which are thus altered are just those which mark off one race from another. How such effects are produced we did not know until 1904, when the late Prof. E. H. Starling, a leader among the great physiologists of our time, laid bare an ancient and fundamental law in the living animal body—his law of hormones. I have pictured the body of a growing child as an immense society made up of myriads of microscopic living units, ever increasing in numbers. One of the ways—probably the oldest and most important way—in which the activities of the communities of the body are co-ordinated and regulated is by the postal system discovered by Starling, wherein the missives are hormones—chemical substances in ultra-microscopic amounts, despatched from one community to another in the circulating blood. Clearly the discovery of this ancient and intricate system opens up fresh vistas to the student of Man's evolution. How Darwin would have welcomed this dis-

covery! It would have given him a rational explanation to so many of his unsolved puzzles, including that of 'correlated variations.' Nor can I in this connection forbear to mention the name of one who presided so ably over the affairs of this Association fifteen years ago Sir E. Sharpey Schafer. He was the pioneer who opened up this field of investigation and has done more than anyone to place our knowledge of the nature and action of the glands of internal secretion on a precise basis of experimental observation. With such sources of knowledge being ever extended and others of great importance, such as the study of Heredity, which have been left unmentioned, we are justified in the hope that Man will be able in due time not only to write his own history but to explain how and why events took the course they did.

In a brief hour I have attempted to answer a question of momentous importance to all of us—What is Man's origin? Was Darwin right when he said that Man, under the action of biological forces which can be observed and measured, has been raised from a place amongst anthropoid apes to that which he now occupies? The answer is Yes! and in returning this verdict I speak but as foreman of the jury—a jury which has been empanelled from men who have devoted a lifetime to weighing the evidence. To the best of my ability I have avoided in laying before you the evidence on which our verdict was found, the *rôle* of special pleader, being content to follow Darwin's own example—Let the Truth speak for itself.

THE STRUCTURE OF AN ATOM OF NITROGEN.—IV.

By HAWKSWORTH COLLINS, B.A. (Camb.).

During the last one hundred years thousands of experimental data have been accumulated by chemists and physicists. Kopp attempted to find the relative volumes of atoms by means of the numerous data of specific gravity, but failed, as shown in the *Chemical News*, 1921, cxxxii, 2. Thomsen in the work of a lifetime hoped to discover the law of heat of formation, but was unsuccessful. Perkins spent his life in the pursuit of the law of magnetic rotation, and Bruhl in the attempt to find the law of optical refractivity. A meeting was arranged between the two latter in an attempt to elucidate their problems in conjunction with one another, but they could find no solution and not even a connecting link of any kind in their results.

The Laws of Relative Volume, Heat of Formation and Magnetic Rotation have now been before scientists for some years with continual demonstrations of the truth of them, but there is no sign yet of any willingness on the part of leading British scientists to admit the correctness of them.

The Law of Optical Refractivity cannot yet be stated with any prospect of recognition, because only eight elements out of about eighty are concerned in the experimental work; however the connection between the experimental results of M.R. and O.R. is continually being demonstrated.

The present paper is the exposition of only one of the seven forms of the nitrogen atom. This particular form has a relative volume of 21.72 in the solid, liquid and aqueous states. Its Heat of Combustion (gas) is 117460, and its Heat of Formation (gas, liq., aq., and solid) is − 117460. Its M.R. is 0.322 and its D.R. is 2.8.

TABLE XXI.
THE RELATIVE VOLUME, 21.72, OF NITROGEN.

		Theor. S.G. at 15°	Obs. S.G.		Corresponds with Nos.
(1)	CH_3NC 15.25 + 16.42 + 21.72 + 0.71	0.758	0.756	14° Gautier	87
(2)	C_2H_5NC 15.25 + 2(16.42) + 21.72 + 0.71	0.780	0.787	15° Pelouze	88
(3)	C_3H_7NC 15.25 + 3(16.42) + 21.72 + 0.71	0.794	0.794	20° Nostrand	89
(4)	C_4H_9NC 15.25 + 4(16.42) + 21.72 + 0.71	0.803	0.803	20° Nostrand	
(5)	Isob.NC 15.25 + 4(16.42) + 2.27 + 21.72 + 0.71	0.796	0.787	4° Gautier	90

(6)	C_3H_5NC 58.29 + 21.72 + 0.71	0.830	0.8355	15° Nostrand	91
(7)	$NC.CH_2.NC$ 2(21.72) + 2(0.71) + 16.42	1.077	1.05	34° Bruhl *i.e.*, 1.066 15°	
(8)	$NC.(CH_2)_2.NC$ 2(21.72 + 0.71) + 2(16.42)	1.029	1.023	45° Simpson	92
(9)	$NC.(CH_2)_3.NC$ 2(21.72 + 0.71 + 3(16.42)	0.999	0.996	11° Henry	
(10)	HgC_2N_2 17.85 + 2(21.72 + 0.71)	4.003	4.003	14° Clarke	
(11)	$HgNO_3.H_2O$ 17.85 + 3.8 + 3(7.53) + 14.03	4.788	4.785	Playfair	
(12)	HgClCN 17.85 + 15.085 + 8 + 16.02	4.57	4.58	22° Wittemann	
(13)	$Na_4Fe(CN)_6.10H_2O$ 4(11.865) + 10.08 + 6(21.72 + 0.71) + 10(14.03)	1.456	1.458	Nostrand	
(14)	NaCl 11.865 + 15.085	2.17	2.17	20° Kaye	
(15)	$FeCO_3$ 10.08 + 8 + 7.53 + 2(2.51)	3.79	3.796	0° *Kopp*	
(16)	$Na_2Fe(CN)_5NO. 2H_2O$ 2(11.865) + + 7.05 + 5(21.72 + 0.71) + 3.8 + 2.51 + 2(14.03)	1.68	1.68	17° Nostrand	
(17)	$FeSO_4.H_2O$ 7.05 + 35.61 + 14.03	3.00	3.047 2.994	Playfair 15° Thorpe	
(18)	Me.SNC 15.25 + 16.42 + 15.53 + 21.72 + 0.71	1.05	1.069	4° Nasini *i.e.*, 1.06 15°	9
(19)	Isopr.SNC 15.25 + 3(16.42) + 2.27 + 15.53 + 21.72 + 0.71	0.964	0.963	20° Henry	
(20)	Ibob.SNC 15.25 + 4(16.42) + 2.27 + 15.53 + 21.72 + 0.71	0.949	0.943	20° Nostrand *i.e.*, 0.947 15°	
(21)	Isoam.SNC 15.25 + 5(16.42) + 2.27 + 15.53 + 21.72 + 0.71	0.94	0.94	17° Nostrand	
(22)	C_3H_5SNC 55.26 + 15.53 + 21.72 + 0.71	1.06	1.056	15° Nostrand	
(23)	C_2N_2 liq. 2(8 + 21.72)	0.87	0.866	17° Faraday *i.e.*, 0.87 15°	9
(24)	CNH 8 + 21.72 + 8.59	0.705	0.697	18° Nostrand *i.e.*, 0.70 15°	
(25)	C_3H_5NC 55.26 + 21.72 + 8	0.79	0.794	17° Nostrand	
(26)	C_6H_5NC {77.48 / 77.45} + 21.72 + 8	0.975	0.9775	15° Nostrand	
(27)	HCNS 12.22 + 8 + 21.72 + 15.53	1.027	1.022	Porrett	
(28)	CH_3NCS 12.22 + 16.42 + 21.71 + 8 + 10.51	1.060	1.069	4° Nasini i.e., 1.06 15°	
(29)	C_2H_5NCS 15.25 + 2(16.42) + 21.72 + 8 + 10.51	0.985	0.995	4° Nasini *i.e.*, 0.984 15°	
(30)	C_6H_5NCS 77.48 + 21.72 + 8 + 10.51	1.148	1.138	15° Nostrand	
(31)	$p.CH_3.C_6H_4.NCS$ 15.25 + 16.42 + 59.2 + 21.72 + 8 + 15.53	1.095	1.087	25° Nostrand i.e., 1.095 15°	
(32)	C_6H_5NCO {77.48 / 74.45} + 21.72 + 8 + 2.51	1.10	1.09	26° Nostrand *i.e.*, 1.10 15°	
(33)	C_6H_5NCO 77.48 + 21.72 + 8 + 2.51	1.085	1.092	15° Nostrand	
(34)	NOCl 21.72 + 2.51 + 23.01	1.386	1.425 1.4165	~15° Nostrand ~ 12° Nostrand e., 1.386 15°	

(36)	N_2O 2(21.72) + 4.45	0.92	0.987	0° Nostrand *i.e.*, 0.925 15°	
(37)	N_2O 2(21.72) + 7.53	0.863	0.87	15° D'Andreeff	
(38)	NO_2 liq. 21.72 + 7.53 + 2.51	1.45	1.45	Dulong	
(39)	N_2O_3 liq. 2(21.72) + 4.45 + 2(2.51)	1.44	1.447	- 2 Nostrand	
(40)	NO_2Cl 21.72 + 2(7.53) + 23.01	1.36	1.37	8° Baudrimont *i.e.*, 1.36 15°	
(41)	$Cl.C_6H_2(NO_2)_3$.2.4.6. 23.01 + 6(0.71) + 2(15.25) + 3(26.74)	1.794	1.797	20° Nostrand	
(42)	$CH_3.C_6H_2(NO_2)_3$.2.4.6. 12.22 + 16.42 + 6(0.71) + 2(12.22) + 3(26.74)	1.65	1.654	Nostrand	
(43)	$CH_3.C_6H_2.(NO_2)_3$.2.3.4. 12.22 + 16.42 + 6(0.71) + 12.22 + 15.25 + 3(26.74)	1.62	1.63	Nostrand	
(44)	Nitropropane $NO_2C_3H_7$ 26.74 + 3(16.42) + 12.22	1.01	1.00	16° Nostrand	
(45)	Nitroheptane 26.74 + 7(16.42) + 12.22	0.942	0.937	19° Beilstein *i.e.*, 0.94 15°	
(46)	$(NO_2)_2.C_6H_4$ 2(26.74) + 59.2	1.49	1.369	98° Schiff *i.e.*, 1.49 15°	
(47)	Picric acid $OH.C_6H_2.(NO_2)_3$ 7.53 + 5.76 + 6(0.71) + 2(15.25) + 3(26.74)		1.777	4° Schroder	
		1.785	1.813	Rudorff	
(48)	$NO_2.C_6H_5$ 26.74 + 74.45	1.215	1.2045	25° Kahlbaum i.e., 1.215 15°	
(49)	$(CH_2Cl)_2$ $CH.NO_3$ 2(16.42) + 2(23.01) + 0.71 + 5.76 + 34.27	1.455	1.459	15° Nostrand	
(50)	$CH_2Cl.CHNO_3.CH_2NO_3$ 2(16.42) + 0.71 + 5.76 + 23.01 + 2(34.27)	1.532	1.540	15° Nostrand	
(51)	$HNO_3.H_2O$ 5.76 + 34.27 + 14.03	1.498	1.486	Smith	
(52)	$HNO_3.3H_2O$ 5.76 + 34.27 + 3(14.03)	1.424	1.424	Smith	
(53)	$CH_3.NO_3$ 12.22 + 16.42 + 34.27	1.22	1.22	15° Perkins	79
(54)	$C_2H_5NO_3$ 15.25 + 2(16.42) + 34.27	1.105	1.107	25° Gladstone	
			1.104	25° Kahlbaum	80
(55)	$C_3H_7NO_3$ 15.25 + 3(16.42) + 34.27	1,063	1.063	15° Perkins	81
(56)	Isob.NO_3 15.25 + 4(16.42) + 2.27 + 34.27	1,013	1,014	25° Nostrand	82
(57)	Isoam.NO_3 15.25 + 5(16.42) + 2.27 + 34.27	0.993	1.000	7.5° Nostrand *i.e.*, 0.994 15°	
(58)	$NO_3.(CH_2)_2.NO_3$ 2(34.27) + 2(16.42)	1.490	1.496	15° Perkins	
(59)	Nitroglycerine 3(34.27) + 2(16.42) +0.71 + 5.76	1.597	1.595 to 1.600	15° De Vrij	
(60)	$2(BiO.NO_3).H_2O$ 2(21.29 + 2.51 + 34.27) + 14.03	4.55	4.55	Playfair	
(61)	CCl_3NO_2 0.71 + 3(23.01) + 31.76	1.62	1.69	0° Thorpe	
			1.6	Chem. Kal.	
(62)	CH_3NO_2 12.22 + 16.42 + 31.76	1.01	1.0236	101° Schiff	
			0.991	Strecker	
(62A)	$C_2H_5NO_2$ 15.25 + 2(16.42) + 31.76	0.939	0.947	15° Liebig	
			0.900	15.5° Brown	
(63)	$C_6H_5N_3$ 74.45 + 21.72 + 9.5 + 3.8	1.09	1.098	10° Nostrand	
(64)	CH_3N_3 12.22 + 16.42 + 21.72 + 9.5 + 3.8	0.896	0.896	8° Nostrand	
(65)	$I(CH_2)_2N_3$ 32.77 + 2(16.42) + 21.72 + 9.5 + 3.8	1.957	1.9154	25 Forster *i.e.* 1.93 15°	

(66)	N_2O_5.liq. 21.72 + 12.23 + 2(4.45) + 8(7.53)	1.65	1.642	18° Nostrand *i.e.*, 1.65 15°	75
((67)	N_2O_5.solid 21.72 + 12.23 + 0.886 + 4(7.53)	1.66	1.642	18° Nostrand *i.e.*, 1.65 15°	78
(67A)	Isob.NO_2 15.25 + 4(16.42) + 2.27 21.72 + 7.53 + 4.45	0.88	0.894 0.877	0° Chapman 16° Chapman *i.e.*, 0.88 15°	83
(68)	$C_3H_7NO_2$ 12.22 + 3(16.42) + 21.72 + 7.53 + 4.45	0.935	0.935	21° Nostrand	
(68A)	$C_5H_{11}NO_2$ 12.22 + 5(16.42) + 2.27 + 21.72 + 4.45 + 7.53)	0.90	0.902	Hilger	

(To be Continued Next Week.)

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

A MESSAGE FROM H.R.H. THE PRINCE OF WALES, K.G., F.R.S., ON LAYING DOWN THE PRESIDENCY OF THE ASSOCIATION.

"My year of office as President of the British Association has come to an end, and I can only express my regret to the members of the Association, and to our hosts the City and University of Leeds, that I am unable to attend personally in order to take my leave.

At Oxford last year I ventured in my address to lay before the meeting a view of the relations between Science and the State. I felt subsequently some justification for having chosen this topic, when I observed in the proceedings of the Imperial and Colonial Conferences of the past year the extraordinary emphasis laid upon the value of scientific research in relation to imperial development. Both conferences set up special committees on research, and we cannot bnt believe and rejoice that the foundations of an imperial scientific service are being firmly laid. The Prime Minister of Australia indicated 'the application of science both to our primary and secondary industries' as 'the most important thing for Empire trade'; more recently our ex-president, the Earl of Balfour, invited the attention of the House of Lords to 'the enormous value of the work given by men of science, with the most lavish generosity' to the study of problems of the common welfare.

Such events as these place it beyond doubt that one of the main objects of the British Association itself is in process of achievement, namely that of 'obtaining more general attention for the objects of science.' The Association, the so-called parliament of science, is one of the chief instruments to that end, and I trust that the public support will continue in increasing measure, to be accorded to its work. Its powers, I am happy to say, have been very materially strengthened, during my own term of office, through the splendid generosity of Sir Alfred Yarrow, in making a gift of £10,000 for the general purposes of the Association, to be expended, in accordance with his wise provision, in the course of twenty years. I gladly take this opportunity of publicly repeating the thanks of the Association to Sir Alfred Yarrow.

In resiging the chair to Sir Arthur Keith, I can wholeheartedly congratulate the Association on its choice of my successor. His name stands very high in the science of man's origin and early biological history. I have reason to believe that when anyone in this country digs up a bone his first instinct (subject to the intervention of the police) is to send it to Sir Arthur Keith. You are to hear from him an address on Darwinism as it stands to-day—a subject of perennial interest, and more than once one of warm controversy at our own meetings. The occasion of the Presidential Address does not (I am thankful to say) lend itself to controversy, but the warmth I am sure you will supply in your welcome to Sir Arthur Keith, and, meeting as you are in Leeds, that warmth will be increased by the traditional quality of Yorkshire hospitality.

(Signed) EDWARD P.,

President.

General Notes.

BRITISH IRON AND STEEL PRODUCTION.

Production of pig-iron amounted to 645,800 tons in July as against 651,300 tons in June and 720,100 tons in May, while the output of steel ingots and castings totalled 682,900 tons, 747,300 tons and 884,600 tons respectively.

DEALERS' STOCKS OF RUBBER IN SINGAPORE AND PENANG.

The Malay States Information Agency in London reports that dealers' stocks of rubber in Singapore on 31 July last amounted to 18,674 tons, and in Penang to 3,884 tons.

NEW GEOLOGICAL MAP OF NOVA SCOTIA.

The Dominion Department of Mines at Ottawa has just issued a second edition of Geological Survey Map 39a, which is the Nova Scotia Sheet, 1 inch to 8 miles.

Copies of the map may be obtained by parties interested on application either to the Geological Survey, Ottawa, or to the Natural Resources and Industrial Information Branch, Canadian Building, Trafalgar Square, London, S.W.1.

THE NATURAL RESOURCES AND INDUSTRIAL INFORMATION BRANCH.

Mr. P. M. Dearle, the officer in charge of the Natural Resources and Industrial Information Branch, Office of the High Commissioner for Canada in London, sailed for Canada on August 13, in the company of the British delegates to the second (triennial) Empire Mining and Metallurgical Congress.

BOARD OF TRADE ANNOUNCEMENT.

SAFEGUARDING OF KEY INDUSTRIES.

The Treasury have exempted from duty under the Finance Act, 1926, imported Ethylene glycol (Glycol; Alcohol ethylene), and Glycol ethers, from 19 August, 1927 to 6 March, 1928.

The Treasury Order will be published shortly.

CZECH-SLOVAK SILVER AND LEAD OUTPUT.

In 1925 the output of the mines at Pribram in Bohemia was 22.136 kilograms of pure silver, 17,209 kilograms of lead and 3.297 kilograms of antimony. In 1926 the figures were 23.697 kilograms of silver, 19.228 kilograms of lead, and 3.124 kilograms of antimony. There was, it will be seen, an increase of some 7 per cent. in the output of silver, and of nearly 11 per cent. in the output of lead.

EMPIRE MINING CONGRESS.

In Montreal on August 22 was opened the second (triennial) meeting of the Empire Mining and Metallurgical Congress at which hundreds of mining men from all parts of the Empire will gather to discuss many important matters related to the devolopment of the Empire's mineral wealth. The technical side of the programme will include the presentation of papers containing the results of extensive research on problems encountered in various economic phases of mining and metallurgy, and this opportunity for the exchange of views and ideas will be of the greatest value to the mining and metallurgical industries not only within the Empire, but throughout the world.

CANADIAN EMPIRE MINING CONGRESS.

The second triennial Empire Mining Confiress which opened at Montreal on August 22, under the presidency of Sir Robert Horne, with over five hundred delegates in attendance from all parts of the Empire, endorsed unanimously a resolution proposed by Mr. R. E. Palmer, president of the British Institution of Mining and Metallurgy, London, embodying the suggestions contained in the paper read before the Congress by Sir Thomas Holland, former director of geological survey in India for the survey of the "mineral resources of the Empire."

Sir Thomas urged the necessity of reviewing for each unit of the Empire the mining resources for smelting capabilities with a view to accumulating in addition to the ordinarq official statistics the essential data necessary for the formulation of an Empire economic policy.

He noted that the British Empire produced about one-quarter of the total world's

mineral production of nearly two billion tons. But the Empire was not independent and completely self-contained in respect of mineral requirements, and he suggested that it might be desirable to carry surplus stocks of vital mineral necessities which could be drawn upon in any temporary emergency, such as, for instance, in the case of nickel in the time of the Great War.

The Congress adopted the resolntion as a move towards vast and far-reaching possibilities, achieving a comprehensive tabulation of the Empire's mineral and industrial resources.

After Sir Robert Horne's Presidential Address, Mr. Stewart, the Federal Minister of Mines, extended a welcome on behalf of the people of Canada to the delegates.

In an outline of Canada's mineral activities, Mr. Stewart said that the Dominion produced over forty different primary metals and minerals standing first in the world in the production of asbestos, nickel and cobalt, third in gold and silver, fifth in lead and zinc and sixth in copper.

Per capita production of minerals last year totalled 26.5 dollars.

Mr. Stewart said "no one here will question the desireability of increasing the production of British investment in Canadian mines. I know that certain powerful groups in the Mother country are interesting themselves in Canada.

I have no doubt that this Congress will exert a powerful influence in exciting interest in Great Britain in Canadian mineral resources."

COPPER IN THE U.S.A.

General Conditions.

In 1925 both production and consumption of copper showed an increase over the former peace-time records of 1924. Though the average price received (14.2 cents) was lower than the pre-war price of 1913 (15.5 cents)), it exceeded that of 1924 (13.1 cents) by a little more than a cent. Many companies resumed the payment of dividends and some others declared *larger* dividends than they had been paying. It is evident that the low selling price of copper in recent years has encouraged consumption, discouraged the search for substitutes, and resulted in the finding of many new uses for the metal. Undoubtedly substitutes would have been employed for some uses had prices been higher, whether or not such substitutes could have met requirements as well as copper.

Both imports and exports of copper decreased, but exports drew more heavily on domestic production than in the preceding year, because the decrease in imports was about three times that in exports. The increase in net exports, together with that in domestic consumption, caused a large decrease in stocks of refined copper; in consequence these stocks at the end of 1925 were only a little more than one-half as large as at the end of 1924. Stocks of blister copper increased, however, but this increase was only about one-third of the amount of the decrease in refined stocks.

Smelter Production.

The copper output of the United States smelters in 1925 from domestic ores exceeded the peace-time record output of 1924 by 40,620,694 pounds. Three smelters that were busy during a part of 1924 were idle during the entire year of 1925—the smelters of *The Old Dominion Co., at Globe, Ariz.*, the Southwest Metals Co., at Humboldt, Ariz.; and the East Butte Copper Mining Co., at Butte, Mont. The smelter of the United States Smelting, Refining and Mining Co., ran only until September 1, 1925. The smelter and other properties of the Ducktown Sulphur, Copper and Iron Co., were sold during the year to the Ducktown Chemical and Iron Co., an American company.

The domestic smelter output from ores of domestic origin represented 56 per cent. of the world's copper production in 1913, 61 per cent. in 1918, 57 per cent. in 1920, 41 per cent. in 1921, 51 per cent. in 1922, 53 per cent. in 1923, and 55 per cent. in 1924 and 1925.

THE NEW ENGLISH CHEMICAL TRUST.

With the recent formation of a British *Chemical Trust, chemical* production throughout the world assumes a new aspect, states *The Index*, published by The New York Trust Company.

"By the amalgamation of the four principal chemical producers in England, an important step towards a lasting and far-reaching readjustment of post-war relations in this field has now been taken. The English are interested in availing themselves of certain German inventions, especially the newly invented manufacture of methyl alcohol and the process of obtaining *motor oil from coal*. In return they would arrange for the German Dye Trust to share in the British market,

" The experience of German Manufacurers has been of great value. The German producers already had derived great dvantages from the working agreement by which they were operating prior to their merger last year by pooling their experience and resources in undertaking and developing experiments, and in exploiting commercially profitable new inventions. The results expected by the British from their amalgamation, while somewhat different, call for basically the same methods.

" To this end they have formed a corporation capable of covering the British market and of holding a position similar to that of the German Dye Trust in the German market. The four companies now merged are Brunner Mond & Company, Nobel Industries, Ltd., British Dyestuffs Corporation and United Alkali Works. The new trust, operating under the name of the Imperial Chemical Industries, has a capital of £66,291,181, as againsht the German Dye Trust capitalisation of £55,000,000."

NOTICES OF BOOKS.

The Industrial Chemistry of Fats and Waxes. By T. P. Hilditch D.Sc (Lond.), F.I.C. With an Introduction by E. Frankland Armstrong, D.Sc., LL.D., F.R.S. Demy 8vo. Pp. XV + 461. Price 18s. net. London : Baillière, Tindall & Cox, Henrietta Street, Covent Garden, W.C.2.

All will agree that the industrial chemistry of fats and waxes is of the greatest importance, and a knowledge of their nature and chemistry cannot be otherwise than interesting and useful. The present work meets the situation adequately. It will prove helpful to the student and a source of convenience as a reference book to all engaged in the above widespread and important industries.

Elementary Practical Physical Chemistry. By James Frederick Spencer, B.Sc. Pp. VIII + 265. Price 5s. London : G. Bell & Sons, Portugal Street, London, W.C.2.

This is a practical book, and aims at catering for the junior student who is thirsting for experiments in physical chemistry. The instructions are explicit and there follow over one hundred experiments, dealing with the more important branches of the subject. It is a cheap and useful handbook

Phosphoric Acid, Phosphates, and Phosphatic Fertilizers. By William H. Waggaman, assisted by Henry W. Easterwood. Pp. 370. New York : The Chemical Catalog Company, Inc., 419, Fourth Avenue, at 29th Street, U.S.A.

This is one of the American Chemical Society's useful monograph series, and comes with excellent credentials which are justified by the contents. Always important, phosphoric acid assumed an increased importance consequent on the increased use of fertilisers. Hence the necessity for up-to-date knowledge of the subject. The present book is authoritative and its contents so varied as to pretty well cover the field. There is given an exhaustive table of contents, and a series of useful tables of processes, etc.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

21,044.—Busching, W.—Process for denitrating of waste acid mixtures. August 9th.

21,018.—Cehmische Fabrik auf Actien vorm. E. Schering.—Manufacture of disodium salts of sulphonethylaminometalmercapto sulphonic acids. August 9th.

21,078.—Trunn, H. O.—Containers for hydrofluoric acid, etc. August 10th.

Specifications Published.

275,284.—I. G. Farbenindustrie Akt.-Ges. Manufacture and production of organic compounds containing oxygen.

253,542.—Darrasse, L., Darrase, E., and Dupony, L.—Manufacture of synthetic camphor.

274,(877.—Mackert, Dr. A.—Process for the catalytic methylation of ammonia and organic amines.

Abstract Published.

278,244.—*Dicarboxylic acids.*—Riedel Akt.-Ges., 1, Riedelstrasse, Britz, Berlin. Hydroaromatic dicarboxylic acids and their derivatives are obtained by the oxidation of either wholly or partly hydrogenated cyclic alcohols and ketones, such as α- and β-tetrahydronophthols, hydrindone, α- and β-decahydronaphthols, in the presence of oxygen carriers, for example, mercuric oxide, molybdenum pentoxide, vanadium pentoxide, and the corresponding metallic salts. In an example a mixture of cis- and *trans*-hexahydro-*o*-phenylenediacetic acid and octohydrocinnamic-*o*-carboxylic acid are obtained by adding decahydronaphthol to 60 per cent. nitric acid which has been treated with vanadinate of ammonium and heating.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

HERCULES.

473,584.—Collodion Cotton Wet and Pyroxylin Wet, being chemical substances in Class 1, for use in manufactures.—Hercules Powder Co., 900, Market Street, Wilmington, New Castle County State of Delaware, United States of America. August 17th.

SEROCALCIN.

482,078.—Chemical substances prepared for use in medicine and pharmacy.—Endocrines, Ltd., 72, Wigmore Street, London, W.1. August 17th.

LEONIL.

479,362.—Chemical substances in Class 1, used as emulsifying agents and for facilitating the wetting of fibrous materials such as textile fibres and fabrics. — I. G. Farbenindustrie Aktiengesellschaft, Mainzerland strasse 28, Frankfort-on-Main, Germany. August 17th.

PERLANO.

478,593.—Chemical substances in Class 1, for use in the dying industry.—H. Th. Bohme Aktiengesellschaft, 29, Moritzstrasse, Chemnitz, Germany. August 17th.

GEN. INDEX TO THE "CHEMICAL NEWS"—VOLS. 1 TO 100.

This large volume contains a detailed Index to the first 100 volumes of the *Chemical News*, and will be found of great value to all interested in Chemical, Engineering, Electrical, and General Scientific subjects. It has been compiled with great care, is handsomely bound in red cloth, and has been produced at great expenditure of time, labour and money. Carriage paid, Great Britain, 21/- net; Carriage paid to Foreign Countries and the Colonies, 22/- net.

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CO-ORDINATION COMPOUNDS.

By DR. N. V. SIDGWICK, O.B.E., Sc.D., F.R.S. (President of the Section).

When the British Association last met in Leeds, thirty-seven years ago, the attention of Section B was largely devoted to the discussion of ionisation ,and at a joint meeting with Section A the new theory of Arrhenius was defended by van 't Hoff and Ostwald against the attacks of such conservative diehards as S. U. Pickering and Prof. H. E. Armstrong. That meeting may be taken as marking the recognition in this country of the distinction between ionised and non-ionised linkages. It seems appropriate, therefore, that I should devote this address to the discussion of a third species or sub-species of atomic linkage, that of co-ordination.

The theory of co-ordination is indeed by no means new; it is only a few years younger than that of electrolytic dissociation; but its interpretation, and especially the establishment of its relation to the older theory of structural chemistry, have only become possible through the advance made in our knowledge of atomic structure in the last few years; and there are still many points in which its bearing on questions of general chemistry is not yet fully realised.

Werner's Theory of Co-ordination, which was first put forward in 1891, the year after our last meeting at Leeds, originated in an attempt to explain the structure of certain compounds formed by apparently saturated molecules with one another. A large number of such compounds, often very stable, had been observed, but they were commonly disregarded by chemists, or were shelved under the convenient name of molecular compounds; and such attempts as had been made to formulate them on the lines of structural chemistry had been conspicuously unsuccessful. The most marked peculiarities of these compounds were three. In the first place their structure appeared to be quite independent of the ordinary rules of valency, according to which the numerical value of the valency of an atom element was primarily determined it belonged, first rising and then falling by by the group in the periodic table to which single units as we go from one group to the

next. In these compounds the structure was rather determined by the tendency of four or six atoms or groups to arrange themselves round a central atom. Secondly, in these complexes, a univalent atom or group of atoms, such as chlorine or NO_2 could be replaced by a whole apparently saturated molecule such as water or ammonia without affecting the stability of the complex. Thirdly, such replacement was always accompanied by a remarkable change in the ionisation of the molecule. Thus, platinic chloride $PtCl_4$ combines with six molecules of ammonia forming a compound $Pt(NH_3)_6Cl_4$, in which all four chlorine atoms are ionised. As the ammonia molecules are removed one by one, the chlorine atoms appear to take their places in the non-ionised part of the molecule, until we reach $Pt(NH_3)_2Cl_4$, which is not ionised at all, and is not a salt: every replacement diminishes the positive charge on the platinum complex by one. If more ammonia molecules are replaced by chlorine atoms, the ionisation occurs again, but not the complex has acquired a negative charge, so that we finally reach the well-known "double salt" K_2PtCl_6.

To explain these phenomena, Werner proposed a theory of molecular structure founded on entirely new principles; that it was determined by the tendency of atoms, irrespective of the periodic groups to which they belonged, to attach to themselves a definite number (usually six, sometimes four, and less often other numbers) of other atoms or groups, which might either be univalent radicals or whole molecules capable of independent existence. These groups together with the central atom formed the "co-ordination complex," and the groups were said to occupy the "first sphere" of combination of the central atom; the molecule might also contain other atoms or groups occupying a "second sphere," which were less firmly attached, and did not count as part of the co-ordination complex. For example, in the hexammine of platinic chloride $[Pt(NH_3)_6]Cl_4$, the ammonia molecules were regarded as occupying the first sphere of the platinum and satisfying its co-ordination number 6, while the chlorine atoms occupied the second sphere. Experimentally the groups in the second sphere were distinguished by the fact that they were ionised in water, while those forming part of the co-ordination complex were not. Werner produced a great mass of evidence in support of these views; the chemical public in general did not, however, pay much attention to them until in 1911 Werner was able to show that certain compounds of chromium and other elements which, on his theory, should have asymetric molecules could actually be resolved into their optically active forms. It then became evident that the theory must at least contain a large element of truth.

Thus, some fifteen years ago, Werner had been able to demonstrate that his theory accounted for the structure of a large number of (mainly inorganic) compounds, with which the ordinary structural theory was not able to deal. He himself applied the theory to organic compounds as well: he regarded it as a general theory of molecular constitution, and sought to show that the structural theory failed even in dealing with organic compounds. But this must be admitted to be the weakest part of his argument: he was not really able to prove that the structural theory was inadequate in the sphere of its greatest triumphs, that of organic chemistry.

An impartial critic writing at this time (say, in 1913) might have summed up the position thus: The theory of structural chemistry gives a satisfactory account of the molecular constitution of nearly all organic and a certain number of inorganic compounds, but it is unable to deal with a large number of substances of the latter class. The theory of co-ordination, which proceeds on wholly different lines, is able to explain the structure of those compounds with which the former theory breaks down: it can account for their composition, their properties, their isomerism, and even their stereoisomerism. There thus appear to be two different modes of chemical combination, each holding within its own sphere but neither applicable to the whole of chemistry. This was obviously a most unsatisfactory position, and one which could only be temporary. It was clear that the true theory of molecular structure when it was discovered must be one which would apply to all compounds, both organic and inorganic, and that the two rival theories, that of structural chemistry and that of co-ordination, must ultimately prove to be two partial aspects of the same general phenomenon.

The final solution of the problem was scarcely to be expected until a more definite idea had been reached of the physical mechanism of atomic linkage, and this could only be attained when more was known of the structure of the atom. The discovery

by *Sir Joseph Thomson and others of the* electron as a universal constituent of all forms of matter had suggested that it was *in this that the mechanism of valency was* to be sought; but a further development of our knowledge of the electronic arrangement was necessary before it could be applied in detail to answer the questions asked by the chemist. This development was reached, in the years from 1911 onwards, mainly through the work of Rutherford, Bohr, and Moseley. Through their researches we learn that the atom consists of a positive nucleus surrounded by groups of electrons, *and that each successive element* in the periodic table contains one more unit of positive charge on its nucleus than the one before it, and one more planetary electron; the atomic number being at once the ordinay number of the element in the periodic table, the number of units of positive charge on the nucleus, and the number of surrounding electrons. The conceptions of the nuclear atom and of atomic number may be said to give us the empirical formula of the atom. The next stage, the determination of the structural formula, of the way in which the surrounding atoms are arranged, although it is not yet complete, has been so far developed by means of the Bohr theory and its subsequent modifications, that we are now in a position to apply the physical results to the solution of the purely chemical problems of valency and molecular structure.

It is evident that the cause of chemical combination is the striving of atoms to attain these numbers of electrons, or some-planetary electrons by some kind of redistribution. The inert gases, since they do not enter into chemical combination, must already possess an arrangement too stable to be capable of improvement; their atomic numbers therefore give us the sizes of a series of completed or stable groups, and it may be expected that when other atoms combine to form a molecule, they thereby attain these numbers of electrons ,or something like them.

The application of these ,ideas in detail to the explanation of valency was primarily due to Kossel and G. N. Lewis, who published their views almost simultaneously in 1916. Kossel dealt with ionised links, and showed that their structure could be explained by supposing that they were due to the migration of one or more electrons from an atom which had a few more than a stable (inert gas) number, to another which had a few less; hence the valency in ionised compounds was usually *equal to the number of* places by which an element was removed from an inert gas, and was positive if it *came after the inert gas, and negative if it* came before. The more difficult problem of the nonionised link, such as we find in elementary chlorine or hydrogen, or in methane, was explained by Lewis by the assumption that it is possible for two atoms, each of which is a few electrons short of a stable number, to share electrons in such a way that each counts as part of the constitution of each atom, thus forming a link which is not merely due to electrostatic *attraction, and so cannot be ionised.*

These views of the two fundamental kinds of linkage ionised and non-ionised, polar and non-polar, or, as Langmuir has conveniently called them, electrovalent and covalent—that one is due to the transference and the other to the sharing of electrons between two atoms, has been confirmed by all subsequent discoveries, and may be taken to be generally accepted. The atomic models on which both Kossel and Lewis founded their theories have indeed been shown to be impossible. These authors supposed that the electrons surrounding the nucleus were at rest, and Lewis *in particular assigned to* them definate positions in his famous cube, which was subsequently developed in so much detail by *Langmuir*. We now know that any such static hypothesis is untenable; it involves the assumption of a variety of *otherwise unknown forces, and it is capable* of explaining many of the properties of atoms, especially their spectra; whereas all these are acounted for by a dynamic model, in which the electrons move in orbits round the nucleus much as the planets move round the sun. But the conceptions of the transference and the sharing of electrons can equally well be applied to the dynamic model of Bohr.

So far the mechanism of valency at which we have arrived is that of structural chemistry rather than that of co-ordination. The numerical value of the valency of an atom appears equal to the excess or defect of its electrons as compared with the stable number of an inert gas. If it has, say, two electrons in excess, loosely attached and forming an imperfect group, it can lose them and become a divalent cation, or it can share them and so form two covalent links; if it has two electrons less than the stable number it can take up two from another atom or atoms and become a divalent anion, or it can share two electrons

belonging to other atoms and become di-covalent; if the excess or defect is two, the valency, of whichever kind, is two also. The next element, with an excess or defect of one, will have a valency of one. We thus arrive at the relation between the valency of an element and its group in the periodic table which was originally pointed out by Mendeléeff. In fact the majority of the structural formulæ of organic chemistry can be translated into electronic formulæ by the simple process of writing two dots (for two shared electrons) in place of a line. It is important to notice the reason for the *two* dots—for Lewis's assumption that two shared electrons are necessary for every covalency. The most familiar property of valency, which has been recognised from the earliest times, is that if one atom combines with another it not only uses up one of its own units of combining power, but one of those of the other atom as well. Where the link is ionised, the reason of this is obvious; the electron which one atom loses must be taken up by the other. But the same must hold with covalency also. If the covalent link consisted of a single shared electron, this would not be true. If the atom A could form a covalent link with B merely by sharing one of its own electrons with B, this would use up one of the units of B, since it would increase B's electrons by *one*; but it would not effect the combining power of A. For example, hydrogen (1) is one electron short of the stable helium number 2; carbon (6) is 4 short of the stable neon number 10. If in methane CH_4 each hydrogen atom is attached to the carbon by a single shared electron, then if this electron is derived from the hydrogen it will satisfy the carbon, but will leave the hydrogen still one electron short; if it is derived from the carbon, it will leave the carbon four electrons short of the stable number. In either case the resulting molecule would be unsaturated, whereas it is in fact saturated. It was to meet this difficulty that Lewis assumed that the covalent link consisted of two shared electrons, one derived from each of the two linked atoms. On this hypothesis the carbon in methane shares one of its four valency electrons with each of the four hydrogen atoms, thus increasing the number of each hydrogen to two, and at the same time each hydrogen shares its own electron with the carbon, thus satisfying the carbon.

We have therefore got an electronic mechanism which will account for the two recognised forms of valency, the ionised and the non-ionised. If these are really the only two forms of linkage which can exist in a molecule, it must be pokssible to extend them so as to account for co-ordination. This is in fact surprisingly simple, and the solution was foreshadowed by Lewis in his paper of 1916. It is clear that the link which attaches one of the groups of a co-ordination complex to the central atom is on the non-polar type. It is an essential point in Werner's theory that such links are not ionised; this is how they are distinguished from the links to atoms in the "second sphere." Thus in the compound $[Pt(NH_3)_4Cl_2]Cl_2$ the two chlorine atoms outside the bracket enclosing the co-ordination complex are ionised, while those inside are not. The same conclusion is supported by the fact that the arrangement of the groups in the co-ordination complex round the central atom can give rise to optical activity; for this, as we know from organic chemistry, is only possible with groups which are attached by covalent links, that is, by directed forces. We must therefore look for an explanation of co-ordination in the formation of covalencies, that is, of links formed of pairs of shared electrons. But they must arise in some way different from that which we have hitherto assumed, since their numerical relations are different; their number is not related to the periodic group of the central atom, and also they can be formed with atoms (such as the nitrogen in ammonia or the oxygen in water) which have already completed a stable number of electrons. Now in the normal covalency formation described above it was assumed that one of the two shared electrons of a link came from each of the two atoms concerned. It is obviously possible that both might be derived from one of them; and the recognition of this possibility is all that is required to provide an electronic mechaniem for co-ordination. By means of this extension of the idea of covalency formation we can explain all the peculiarities of co-ordination compounds, of which, as we have seen, the most important are the power of further combination shown by apparently saturated molecules such as water and ammonia, the attainment of a valency limit (the co-ordination number) independent of the periodic group to which the atom belongs, and the peculiar change of electrovalency which accompanies the replacement of a univalent radical such as

chlorine by a whole molecule such as ammonia. We may consider these in turn. In nitrogen there are five valency electrons; by combination with three hydrogen atoms this number is increased to eight, giving a molecule of ammonia, in which the octet of the nitrogen is complete and the atom is so far saturated. But, though complete, the octet is not fully utilised; six of its members are shared with the three hydrogen atoms, but the other two are unshared, and so can form a fourth link if another atom can be found which will share them without sharing some of its own electrons with the nitrogen in return. This may happen in a variety of ways. A hydrogen ion, consisting of a single proton with no attendant electron, is capable of taking up two electrons, and, as we all knoy, if a hydrogen ion meets an ammonia molecule it combines with it to form an ammonium ion

$$\begin{array}{c} H \\ \cdot\cdot \\ H:N \\ \cdot\cdot \\ H \end{array} + [H]^{+} = \left[\begin{array}{c} H \\ \cdot\cdot \\ H:N:H \\ \cdot\cdot \\ H \end{array}\right]$$

The nitrogen has now shared all its eight valency electrons, two with each of the four hydrogen atoms; but since the ammonia molecule is electrically neutral, while the hydrogen ion is positively charged, the resulting NH_4 molecule is also positively charged. Again, boron has three valency electrons; it can share one of them with each of three chlorine atoms (thus completing the octets of the chlorines), and at the same time take a share in one of the electrons belonging to each of the chlorines. This gives boron trichloride BCl_3, in which the boron has increased its valency group from three to six. The boron cannot combine with a fourth chlorine atom, because, although its own octet is not complete, it has no more unshared valency electrons to offer for a covalent link. But if it meets an ammonia molecule it can share the unshared pair of electrons of the nitrogen, and so form a co-ordinate link :—

$$\begin{array}{c} Cl \\ \cdot\cdot \\ Cl:B \\ \cdot\cdot \\ Cl \end{array} + \begin{array}{c} H \\ \cdot\cdot \\ :N:H \\ \cdot\cdot \\ H \end{array} = \begin{array}{c} Cl\ H \\ \cdot\cdot\ \cdot\cdot \\ Cl:B:N:H \\ \cdot\cdot\ \cdot\cdot \\ Cl\ H \end{array}$$

In this way each of the two atoms assumes a covalency (or, if we prefer to call it so, a co-ordination number) of four.

The conditions for the formation of a co-ordinate link thus are that we should have one atom which has a pair of unshared valency electrons to offer, and another which has room for one or more pairs of electrons in its valency group. It is convenient to have a symbol and a nomenclature to express this process, and I have therefore suggested that, while the ordinary covalent link is represented by a line A—B, the co-ordinate link should be written as an arrow A⟶B, pointing away from the atom which contributes the two electrons of the link; also we may call the atom which lends the electrons (A) the donor, and that which receives them (B) the acceptor.

We have now to apply these ideas to the compounds on which Werner based his theory. Any simple cation—that is, an atom stripped of its valency electrons—can act as an acceptor. It can build up a valency group by sharing electrons belonging to other atoms, that is, by forming co-ordinate links. Thus the chromic ion $[Cr]^{+++}$ contains a stable core of twenty-one electrons and has no valency group; the stability of this arrangement is proved by the stability of the chromic salts. This ion can then form a series of co-ordinate links with molecules of ammonia, by sharing the "lone pair" of electrons of the nitrogen atom. Since the stable size of the valency group for such an ion is 12, six molecules of ammonia will be taken up, and in this way the hexammine $[Cr(NH_3)_6]Cl_3$ is produced. We have thus accounted for the power which certain complete molecules possess of combining further through co-ordination.

The next point is to explain the peculiar change of electrovalency which accompanies the replacement of an ammonia molecule by, say, a chlorine atom. It is natural that if an ammonia molecule is removed, this should be replaced by another covalently linked atom, because that is required to maintain the valency group of 12. When the ammonia is removed it takes away with it the two shared electrons which it originally contributed; the chlorine atom which replaces it supplies one electron to be shared by the chromium, but the chromium is called upon to supply the other electron for the link. Thus the chromium is one electron short of its stable number, and must take up electron from elsewhere to make up the deficiency. In other words the replacement of the ammonia by chlorine will reduce the positive charge on the ion by one unit, giving instead of

$[Cr(NH_3)_6]^{+++}$ the ion $[Cr(NH_3)_5Cl]^{++}$, or the salt $[Cr(NH_3)_5Cl]Cl_2$. The same change will occur for every replacement of a whole molecule in the complex by a univalent radical. Thus the very peculiar change of electrovalency which Werner established is a necessary result of the electronic mechanism underlying the linkage. The third important characteristic of the co-ordination compounds is the co-ordination number itself. As we have seen, the most remarkable point about these compounds is that the relation observed in ordinary structural chemistry between the valency of an element and its group in the periodic table disappears. Instead of finding that the valency—the number of links which an atom can form—increases from one in the first group to four in the fourth, and then falls (in the simpler compounds at any rate) to one in the seventh, we find that the co-ordination number is independent of the periodic group, and is usually either six or four. But this again follows necessarily from the theory. So long as the valency is expressed by ionisation, it must be limited either by the number of electrons which the atom has to offer, or by the number for which it has room in its valency group; it will therefore be determined by the distance of the atom in question from the nearest inert gas, or, in other words, by the group in the periodic table to which it belongs. In its saturated compounds the atom will usually be left either with an imperfect valency group (like the boron in boron trichloride) or with one which is incompletely shared, like the nitrogen in ammonia. Where co-ordination occurs this limitation is removed, the atom can give or take as many electrons as may be necessary, and in the fully co-ordinated atom it will have a fully shared valency group. Its maximum co-ordination valency, or co-ordination number, is therefore half the number of electrons in its maximum valency group.

(To be continued.)

THE STRUCTURE OF AN ATOM OF NITROGEN.—IV.

By HAWKSWORTH COLLINS, B.A. (Camb.).

Continued from Page 155, (*Sept.* 2.)

TABLE XXII.

HEAT OF COMBUSTION (GAS).

			Theor.	Obs.		
(69)	Et.N.O_3 27100 + 2(157787) + 117460 - 2(32341) - 71515	=	323937	324040	T.	72
(70)	Isob.N.O_2 27100 + 4(157787) + 659 + 117460 - 32341 - 96155	=	647871	647660	T.	73, 84
(71)	Et.N.O_2 27100 + 2(157787) + 117460 - 32341 - 96155	=	331638	334210		62a

TABLE XXIII.

HEAT OF FORMATION (GAS).

			Calculated by Collins	Calculated by Thomsen	
(72)	Et.N.O_3 7280 + 2(7391) - 117460 + 2(32341) + 71515	=	40799	40780 to 38750	69
	also 2(94418) + 5(34380) - 323937	=	40799		69
(73)	Isob.N.O_2 7280 + 4(7391) - 659 - 117460 + 32341 + 96155	=	47221	47800 to 44900	
	also 4(96418) + 9(34380) - 647871	=	47221		70, 84
(74)	N.O - 117460 + 96155	=	-21305	-21575	

TABLE XXIV.

HEAT OF FORMATION (LIQUID, AQUEOUS AND SOLID).

			Theor.	Obs.	Corresponds with
(75)	N_2O_5.liq. - 2(117460) + 2(71515) + 3(32341)	=	5138	3600	66

(76)	N_2O_5 aq. − 2(117460) + 96155 + 71515 + 3(32341) =	29773	29820	
(77)	N_2O_4 gas and aq. − 2(117460) + 96155 + 71515 + 2(32341) =	−2568	−2650	
(78)	N_2O_5.solid − 2(117460) + 117460 + 4(32341) =	11904	11900	67

TABLE XXV.
MAGNETIC ROTATION, 0.322.

		Theor.	Obs.	Corresponds with
(79)	CH_3NO_3 0.265 + 1.023 + 0.322 + 0.042 + 2(0.202) =	2.056	2.05 to 2.066 Perkins	53
(80)	$C_2H_5NO_3$ 0.235 + 2(1.023) + 0.322 + 0.042 + 2(0.202) =	3.049	3.073 to 3.095 P.	54
(81)	$C_3H_7NO_3$ 0,235 + 3(1.023) + 0.322 + 0.042 + 2(.0202) =	4.072	4.083 to 4.097 P.	55
(82)	Isob.NO_3 0.235 + 4(1.023) + 0.1 + 0.322 + 0.042 + 2(0.202) =	5.195	5.158 to 5.206 P.	56
(83)	Isob.NO_2 0.235 + 4(1.023) + 0.1 + 0.322 + 0.425 + 0.315 =	5.489	5.497 to 5.537 P.	67a
(84)	Nitroisobutane 0.235 + 4(1.023) + 0.1 + 0.322 + 0.042 + 0.202 =	4.993	4.99 P	70, 73
(85)	$C_6H_5CH_2CN$ 10.705 + 1.023 + 0.459 + 0.322 =	12.509	12.472	
(86)	CH_3NO_2 0.265 + 1.023 + 0.322 + 0.042 + 0.202 =	1.854	1.852 to 1.875 P .	62

TABLE XXVI.
OPTICAL REFRACTIVITY, 2.8.

		Theor.	Obs.		Corresponds with
(87	CH_3NC 0.985 + 4.6135 + 2.8 + 2.6685 =	11.067	11.03	Bruhl	1
(88)	C_2H_5NC 0.985 + 2(4.6135) + 2.8 + 2.6685 =	15.6805	15.68	B.	2
(89)	C_3H_7NC 0.985 + 3(4.6135) + 2.8 + 2.6685 =	20.294	20.28	B.	3
(90)	Isoam.NC 0.985 + 5(4.6135) + 2.8 + 2.6685 =	29.521	29.54		5
(91)	C_3H_5NC 14.3745 + 2.8 + 2.6685 =	19.843	19.75		6
(92)	$NC(CH_2)_2NC$ 2(2.8 + 2.6685) + 2(4.6135) =	20.164	20.31	84 B.	8
(93)	Me.SNC 0.985 + 4.6135 + 8 + 2.8 2.6685 =	19.067	19.10	M_D *i.e.*, 19.01 M_α	18
(94)	C_2N_2 2(3.333 + 2.8) =	12.266	12.26	B	23
(95)	o.I.$C_6H_4.N_3$ 13.875 + 24.39 + 2(2.8) + 3.8 =	47.665	48.05	M_D *i.e.*, 47.81 M_α	
(96)	$N_3.C_2H_2.CH_2N_3$ 2(2 × 2.8 + 3.8) + 6.666 + 2(1.125) + 4.6135 =	32.3295	32.61	M_D *i.e.*, 32.45 M_α	

N_3 in Nos. 95 and 96 corresponds with the relative volume of N_3 in Nos. 63, 64 and 65.

In the above tables the relative volume, etc., of C_3H_7 (C_4H_9, etc) is given as follows in order to make the regularity more apparent.

TABLE XXVII.

C_3H_7		=	H	+	$3(CH_2)$
R.V.	64.51	=	15.25	+	3(16.42)
M.R.	3.304	=	0.285	+	3(1.023)
O.R.	14.8255	=	0.985	+	3(4.6135)
H.C. (gas)	500461	=	27100	+	3(157787)
H.F. (gas)	30453	=	7280	+	3(7391)

where

CH_2	=	C	+	H	+	H
16.42	=	0.71	+	9.95	+	5.76
1.023	=	0.459	+	0.165	+	0.399
4.6135	=	2.6685	+	1.125	+	0.82
157787	=	104218	+	27194	+	26375
7391	=	7800	+	7186	+	8005

The iso-compounds differ from the simple ones owing to the fact that an atom of H(12.22) takes the place of an atom of H(9.95); so that these molecules always have a relative volume greater by 2.27 than the simple ones. Iso-compounds are therefore put in the same form as the simple ones with the addition of 2.27, in order to demonstrate the regularity. The corresponding difference in M.R. is 0.1 (= 0.265 − 0.165), whilst in O.R. it is zero, *i.e.*, there is no difference; in H.C. (gas) *it is* 659 (= 27853 − 27194), and in H.F. (gas) − 659 (= 6527 − 7186).

The correspondence of the allyl group in R.V. and O.R. is shown in the following table.

TABLE XXVIII.

	C_3H_5	=	C_2	+	H_2	+	H	+	CH_2
R.V.	58.29	=	2(0.71)	+	2(15.25)	+	9.95	+	16.42
O.R.	14.3745	=	6.666	+	2(0.985)	+	1.125	+	4.6135

When the relative volume of allyl is 55.26 (*Nos.* 22 *and* 25) *one atom of H(15.25) is* displaced by an H(12.22).

In Table XXI. the Rel. Vol. of NO_2 26.74 equals 21.72 + 2(2.51), 31.76 equals 21.72 + 7.53 + 2.51, and that of NO_3 34.27 equals 21.72 + 7.53 + 2(2.51).

When N_2O_5aq. (No. 76) unites with a base,

2(117460)	becomes	− 2(23630)
96155	becomes	8234 1
71515	becomes	32341

i.e., 2(117460 − 23630) + (96155 − 32341) + (71515 − 32341) or 84672 calories are *emitted.*

Exactly the same thing occurs when N_2O_4 aq. (No. 77) unites with a base and an extra atom of oxygen. This is the explanation of the frequent occurrence in nitrates of the additional 84672 calories in previous papers.

There are some other matters involved in *the above Tables which cannot be discussed* at present, such as the position of atoms or groups of atoms in the benzene nucleus.

In No. 83, 0.425 is the M.R. of 0(7.53) when it is doubly linked to the N-atom.

THE ACIDS, ALKALIES, SALTS AND COMPRESSED GASES INDUSTRY IN CANADA, 1926.

A substantial increase in the output of acids, alkalies, salts and compressed gases was recorded in 1926 when production for the industry reached a total value of $30,232,322, or 2.7 million dollars above the corresponding figure for 1925.

(a) *Acids, Alkalies and Salts.*—Output from the 19 plants in Canada producing acids, alkalies and salts as principal products in 1926 was valued at $27,809,836 and, as raw materials cost $12,924,539 delivered at the plant, the value added by manufacturing amounted to $14,885,297. Capital employed stood at $34,589,930 and employment was given to 2,040 people to whom $3,075,649 was paid in salaries and wages during the year.

Of the 19 plants in operation, 11 were in Ontario, 4 in Quebec, 3 in British Columbia, and 1 in Nova Scotia. Sulphuric acid was made in 8 different plants, nitric acid in 2 plants and hydrochloric acid in 2 plants; cyanamide, bleaching powder, sodium cyanide, acetaldehyde, glacial acetic acid, phosphorus, liquid chlorine, soda ash and caustic soda were each made by only 1 firm in Canada. Calcium carbide was made for sale in 2 plants and for intermediate use in one other establishment.

(b) *Compressed Gases.*—Production of compressed gases in 1926 totalled $2,422,486 in value as compared with $2,086,613 in 1925. Capital employed amounted to $3,799,733; employees numbered 360, and expenditures for salaries and wages totalled $521,824.

Of the 24 plants reporting, 11 were in Ontario, 5 in Quebec, 3 in Manitoba, 2 in Nova Scotia, 2 in British Columbia and 1 in Alberta. Three plants in Ontario producing hydrogen for their own use in the hydrogenation of oils have been included in this report for the first time. Acetylene was made in 11 different plants, carbon dioxide in 7 plants, oxygen in 12 plants, hydrogen in 3 plants, and aqua and anhydrous ammonia in 1 plant.

THE WATERS OF SOME CZECHO-SLOVAK HEALTH RESORTS.

By J. G. F. Druce, M.Sc. (Lond.), R.Nat.Dr. (Prague), F.I.C.

Czecho-Slovakia possesses nearly 200 *curative and thermal health resorts*[1, 2]. Of these, Karlovy Vary (Karlsbad) and *Marianske Lazne (Marienbad)* and possibly one or two others are known all over the world. The others are, however, much frequented by the Czechs themselves and by people from neighbouring countries. Thus many Germans and Austrians annually visit Františkovy Lazne (Franzensbad) and Teplice-Šanov (Teplitz-Schonau) in North Bohemia and many Hungarians go to the Tatras and Slovakian resorts. Gradually these places will become more known, and it is therefore of interest to enquire into the nature of the waters from these numerous sources. It is noteworthy that the waters from the resorts along the northern side of the republic, which are usually on the slope of the Ore Mountains, the Giant's Mountains, or the Tatras, have water that is radio-active and it often issues from the springs at considerable temperatures, *e.g.*, the sprudel water at Karlsbad has a temperature of 72° C., and that issuing from the springs of Trenčianske Teplice in Slovakia is 42° C.

Karlsbad, perhaps the best known health resort in the world, attracting 60,000 visitors annually, Marienbad, Františkovy Lazně (Franzensbad), and Teplice are all in N.W. Bohemia. As already stated[1], the Karlsbad sprudel waters rise to a height of about 100 feet. They contain sodium sulphate, bicarbonate and chloride, together with calcium and magnesium bicarbonates. Much gas accompanies this spring water and consists mainly of carbon dioxide (98 per cent.). Inert gases, including radium emanation, make up the bulk of the remaining 2 per cent. of other gases. During the summer months it is no uncommon sight to see thousands drinking the waters in the early morning.

The municipality adopts methods for extracting both crystals and anhydrous Sprudel salts, which are then exposed to the gases which have been removed during the evaporation. The salts thereby acquire a slight radio-activity. It has been calculated that the spring will yield nearly three million litres of waters containing 15,000 kilograms of dry salts daily.

Use is now (1927) being made of the enormous volumes of carbon dioxide, which had previously been allowed to escape. "Gas baths" are the vogue, having been advocated as long ago as 1913. Elaborate precautions are taken to ensure that the gas never rises beyond a certain height, and patients are strapped in chairs so that there is no possibility of their heads falling below the CO_2 level.

In the neighbourhood is Jáchymov (St. Joachimsthal), celebrated for its radium mines and which has now become a health resort. The treatments given here include mud and other warm baths and are efficacious in certain diseases.

Mattoni Water comes from a cold spring at Kysibl (Giesshübl), between Karlsbad and Jachymov. Similar table waters are bottled at Bilin and Krondorf.

Karlovy Vary (Karlsbad.)

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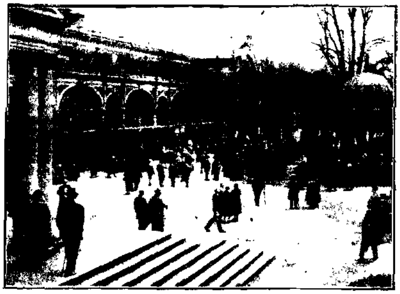
MARIANSKE LAZNE (MARIENBAD).

The waters at Marienbad are cold but contain similar saline constituents to those of Karlsbad. All those of Frantiskovy Lazne contain sodium sulphate and also compounds of iron. The waters from one spring contains 16 gr. Na_2SO_4 per litre, corresponding to 38.6 gr. of Glauber's salt per litre. This is the strongest Glauber's salt solution in the world. There are also springs whose waters contain lithium salts and radium emanation together with free and combined carbon dioxide. It is interesting to note that peat deposits in the vicinity contain ferrous sulphate.

The thermal waters of Teplice-Šanov are almost free from dissolved mineral matter, but have a temperature of 37-51° C. (Czech "Teplice" means "hot springs.")

PODEBRADY.

Among the other Bohemian resorts, mention may be made of Bechyne with its mud baths, which are much frequented by Czechs. The watering place, Podebrady, has only recently been developed, and the mineral water, "Podebradka," is being bottled for table use. According to Prof. Kucera, the waters show a high thorium emanation (4.75 Mache units). The total carbonic acid (free and combined) is 4.944 gr. per litre. The total solids left on evaporating one litre and heating to 110° C. weigh 2.695 gr. This residue contains the carbonates and chlorides of sodium, lithium and iron.



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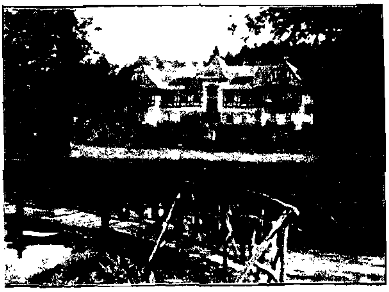
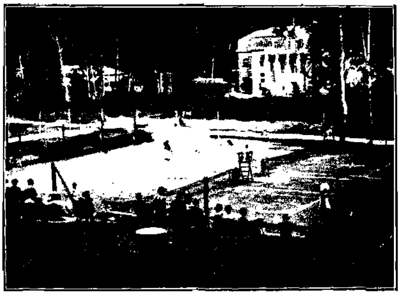


LUHAČOVICE.



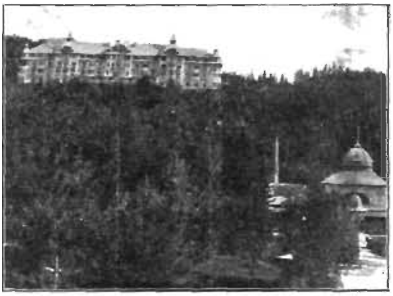
LUHACOVICE.

Janske Lazne (Johannisbad), in the Giant's Mountains, also possesses warm springs (29° C.). Luhacovice, in Moravia, possesses an inhaling establishment with modern installations for treating chronic catarrhs with its gaseous mineral waters.

There are many resorts in Slovakia, but they are mostly unknown outside Central Europe. The majority of the foreigners who frequent them are Hungarians.

Pist'any, one of the State-owned spas, possesses a remarkable curative thermal mud which is thrown up volcanically. It collects in the basin of the *hot springs* forming a soft mass which may be used as compresses. *For home treatment the mud* is dried, pressed and preserved in cubes. These cubes do not give rise to decomposition products on re-treating with water. The dried mud is stated to have a radioactivity of 3,200 Mache units per kilo.

Trencianske Teplice also possesses warm radio active mud which has a temperature of 36-52° C. There are seven mineral *springs issuing from cleft limestone formations*: six of them flow into the natural hydro-therapeutic basins whilst the other one is used for drinking purposes. It is sulphurous but not unpleasant. In addition to the six large natural baths into which the hot waters rise, there are numerous single basin baths into which the water is diverted without the use of pipes. It is impossible to empty some of the baths and keep them empty, so great is the flow of thermal water which in one case amounts to 4,000,000 litres daily. The mud, which can either be used in the "tub" baths or applied locally, is inorganic and is remarkably efficacious. These natural remedies are further augmented by carbonic acid baths and physical and electrical treatments. Trencianske



TATRANSKA LOMNICA.

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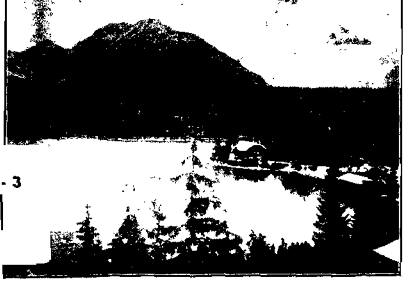

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Teplice thus specialises in curing rheumatism, gout, sciatica, neuralgia, paralysis, and diseases consequent upon injuries to bones and joints. The quiet surrounding scenery and sub-Alpine climate undoubtedly aid its restorative powers and enable treatment to be undergone at any period of the year.

Sliač, in the wooded slops of the River Hron (a tributary of the Danube), has a number of springs with slightly warm mineral water containing much CO_2. Tatranská Lomnica, Poprad and Strbské Pleso are other resorts at the foot of the Tatra mountains, and from them many mountain excursions may be made, but they are also health resorts. Although Strbské Pleso, for instance, is over 4,000 feet above the sea level it enjoys a mild climate and it is claimed that the dust-free air builds up blood cells and has a beneficial effect upon the health generally.

Smokovec, in the same district, has a very large sanatorium for tubercular patients.

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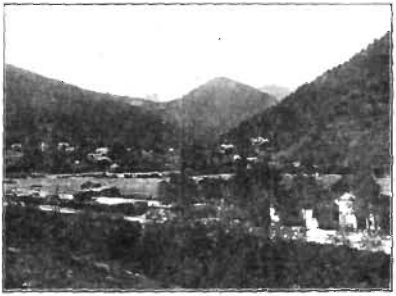
[1] Karlsbad Sprudel Salts, *Chemist and Druggist*, 1926, cv, 708.

[2] Czecho-Slovak Thermal Watering Pla es, *British and Colonial Pharmacist*, 1927, LXXXVIII, 105.



LUBOCHNA.

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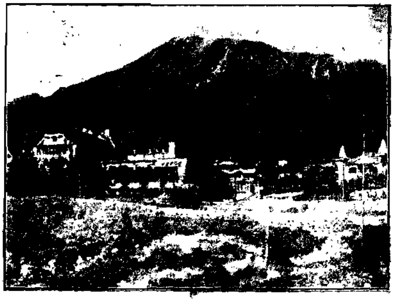

SMOKOVEC.

General Notes.

WEEKLY COAL OUTPUT.

Many comments have been made upon the drop in the output of coal for the week ended July 23 as compared with the output for the week ended July 1 . This decrease was, in fact, 458,000 tons, but the commentators do not appear to have noticed that in the district of Scotland alone there was a drop of no less tha 494,700 tons. This, of course, is accounted for by the fact that the annual holiday took place during the week.

The output actually shewed an increase in Northumberland, Durham, Yorkshire, Stafford, Worcester, and Warwick, and had the Scottish output not been reduced there would actually have been an increase in the total output of the country for the week.

BOARD OF TRADE ANNOUNCEMENT.

Dyestuffs (Import Regulation) Act, 1920.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during July ,has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 641, of which 480 were from merchants or importers. To these should be added 26 cases outstanding on the 30th June, making a total for the month of 667. There were dealt with as follows :—

ranted - 578 (of which 582 were dealt with within 7 days of receipt).

Referred to British Makers of similar products—70 (of which 51 were dealt with within 7 days of receipt).

Referred to Reparation Supplies available- 3 (all dealt with within 2 days of receipt).

Outstanding on 30 July, 1927—16.

Of the total of 667 applications received, 586 or 88 per cent., were dealt with within 7 days of receipt.

INTERNATIONAL FLOUR AND BREAD CONFERENCE.

An International Milling and Baking Industries Conference will be held in Prague at the 'Masaryk Academy of Work' from September 22 to 25. The latest practice and improvements in preparing the grain, the flour and the final baked products will be presented and discussed . This is apparently the first international conference of its kind. Intending participants can obtain special rail and visé facilities. The secretary will be glad to supply further information, letters may be addressed to Prague 1, Staromestské nám. 16.

BOARD FOR MINING EXAMINATIONS.

Examinations for First and Second Class Certificates of Competency as Managers and Under Managers of Mines will be held on 23rd and 24th November, 1927, at Edinburgh, Newcastle-on-Tyne, Sheffield, Wigan, Cardiff and Birmingham.

The written part of an Examination for Certificates of Qualification as Surveyors of Mines will be held at the same centres on 24th November, 1927.

Applications for the necessary forms should be made not later than 11th October, 1927. In order that appropriate forms may be sent, it is important that candidates should state whether they have already sat at one of the Board's Examinations.

Letters should be addressed to the Secretary Board for Mining Examinations, Mines Department, Dean Stanley Street, Millbank, London, S.W.1.

THE SIR JOHN CASS INSTITUTE.

We have received the Syllabus of the Sir John Cass Technical Institute for the coming session. It gives details and information concerning the courses of instruction in the various pure and applied sciences, etc. The Inorganic and Organic Chemistry Departments are particularly strong and from time to time original scientific work from these laboratories appears in *The Chemical News*. The session commences on September 19.

EMPIRE MINING AND METALLURGICAL CONGRESS.

Visit to Canadian Mineral Belt.

The members of the Empire Mining and Metallurgical Congress now touring Canada spent last week investigating the great belt of mineralised country, one thousand miles in length and three hundred miles in width, from North-Western Quebec to Central Manitoba.

In this belt are what are claimed to be the world's greatest nickel mines and vast deposits of gold, silver, copper, cobalt, arsenic, lead and zinc.

The party visited the nickel mines and smelting works, and also the famous cobalt and adjacent silver mines.

The mining experts from all parts of the Empire have been greatly impressed with the potentialities of the whole mineral area and with present developments there.—*Reuters.*

VICKERS LIMITED.

Sir Vincent Caillard, who for 27 years has been a director of Vickers Limited, and who was mainly instrumental in arranging for the recent reconstruction of the Company (which is now practically completed), has tendered his resignation as from September 1, 1927. His colleagues have accepted his resignation with great regret.

SALES OF GERMAN POTASH 1924-27.

Figures published by the German Potash Syndicate for sales during May show the falling off which is characteristic for this month. Total sales during the month under review amounted to 43,071 tons as compared with 41,750 tons during the same month of the previous year. The development of German potash sales from 1924-25 are shown in the following table :—

Month	1924-25	1925-26	1926-27
June	45,490	81,010	82,820
July	57,640	95,020	86,550
August ...	111,560	104,550	101,959
September...	115,860	101,270	82,600
October ...	80,930	72,720	63,090
November...	98,350	57,690	68,870
December...	84,680	58,920	95,730
January ...	165,990	94,970	190,367
February...	202,050	185,510	182,837
March ...	148,980	138,110	164,920
April	66,810	57,290	50,950
May	73,210	41,750	48,071

His Majesty's Consul-General at Cologne (Mr. W. N. Dunn) informs the Department of Overseas Trade that according to figures issued by the Statistical Reich Office and published in the " Deutsche Bergwerkes Zeitung " of August 9, the production of potash salts amounted to 94 mill dz. (1 dz. —100 kgs.) actual weight with 12.6 mill dz. pure potash Thus the potash output as compared with 1925 has decreased by 21.9 per cent., but is still considerably higher than in 1924 and comparatively speaking, falls little short of 1913. The rationalisation of the potash mining industry is seen from the fact that of the 288 potash works to which a participation figure has been allotted, only 66 participated in the output of 1926 on a monthly average as against 85 in 1925 and 126 in 1923. Sales in potash salts have decreased from 48.26 mill dz. with 12.25 mill. dz. pure potash in 1925 to 38.94 mill dz. with some 11 mill dz. pure content or 10 per cent. Of the amounts sold in 1926, 26.85 mill. dz. with 6.94 mill. dz. pure potash were sold on the home market and 12.59 mill. dz. with 4 mill. dz. pure potash abroad. The decrease as compared with 1925 amounted to 11.5 per cent. as regards export sales and 9.5 per cent. as regards inland sales.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

21,501.—Gubelmann, I. — 1-amino-2, 4-dichloro-anthraquinone. August 15th.

21,919.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of ammonia. August 19th.

21,405.—Jordan, H. — Manufacture of alkylisoalkylene-phenols. August 19th.

21,496.—Newport Co. — Preparation of *para*'-hydroxy-ortho-benzoyl-benzoic acid. August 15th.

21,439.—Petersen, H. — Manufacture of sulphuric acid. August 15th.

Specifications Published.

265,545.—Newport Co.—Process of preparing nitro-amino-benzoyl-o-benzoic acid and its derivatives.

275,843.—Lilkenroth, F. G.—Method of producing a mixed manure containing phosphoric acid and nitrogen.

257,747.—Deutsche Gold- und Silver-scheideanstalt vorm. Roessler.—Method of stabilising hydrocyanic acid.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

273,440.—Separating sodium stannate from sodium arsenate and antimonate.—Harris, H, 62, New Broad Street, London.

Mixtures of sodium stannate and sodium arsenate, with or without sodium antimonate, are treated, in the cold, with caustic soda solution of such strength as to dissolve only the sodium stannate, the resulting solution being separated from the residue, and the latter being treated for the recovery of pure sodium arsenate. When treating mixtures consisting only of sodium stannate and arsenate, the solution used may contain from 100 to 250 grms. of caustic soda per litre, but when the mixtures contain free caustic soda, and salts such as sodium chloride or sodium carbonate, as is the case, for instance, with mixtures obtained by the processes described in Specifications 213,638 and 245,479, the strength of the caustic soda solution may be reduced. For example, a mixture containing 5.1 per cent. sodium chloride, 5.8 per cent. sodium carbonate, and 8.5 per cent. caustic soda, may be treated with a solution containing 58 grms. of caustic soda per litre.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

INDICOL.

481,141.—Chemical substances prepared for use in medicine and pharmacy.—William Francis Mildren, 153, Fisherton Street, Salisbury. Aug. 24th.

AMPACOIDS.

482,081.—Chemical substances prepared for use in medicine and pharmacy.—Reed & Carnrick, 155, 157, and 159, Van Wagenen Avenue, Jersey City, State of New Jersey, United States of America. August 24th.

GENERAL INDEX TO THE "CHEMICAL NEWS"—VOLS. 1 TO 100.

This large volume contains a detailed Index to the first 100 volumes of the *Chemical News*, and will be found of great value to all interested in Chemical, Engineering, Electrical and General Scientific subjects. It has been compiled with great care, is handsomely bound in red cloth, and has been produced at great expenditure of time, labour and money. Carriage paid, Great Britain, 21/- net; Carriage paid to Foreign Countries and the Colonies, 23/- net.

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THE CHEMICAL NEWS

VOL. CXXXV. No. 3518.

MERTON HOUSE, SALISBURY SQUARE,

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BRITISH ASSOCIATION for the Advancement of Science.

LEEDS (AUGUST 31—SEPTEMBER 7), 1927.

SECTION B.—CHEMISTRY.

CO-ORDINATION COMPOUNDS.

By DR. N. V. SIDGWICK, O.B.E., Sc.D., F.R.S. (President of the Section).

(Continued from Last Week.)

" In this way the conception of the co-ordinate link as being a covalency, that is, a link of two shared electrons, differing from the ordinary covalency only in this, that the two electrons both come from one of the linked atoms instead of one from each, provides the mechanism required to explain the existence and the properties of the co-ordination compounds of Werner. This conclusion removes the apparent contradiction between organic and inorganic compounds; it refers the structure of molecules of both classes to the same physical principles, and exhibits the original co-ordination theory of Werner and the older structural theory as two aspects of the same general process. It further removes two objections which might have been urged against the co-ordination theory as it was originally proposed. The first of these is that it seemed to assign a unique position to one or two of the atoms in a molecule, in which every atom is in a sense as important as every other. We can now see that this is in fact the case, and that nitrogen in an ammine, for example, is just as much a centre of co-ordination as the metal. The second point is that the distinction which Werner made between principal and subsidiary valencies, which was always unsatisfactory, now disappears. It originated in a desire to retain the valencies of the structural theory, while recognising the formation of more links than the structural theory would permit. It has long been clear that there was no ground for maintaining the existence of this distinction within the co-ordination complex. The electronic theory shows that the difference between a normal and a co-ordinate covalency is in their method of formation; when they have been formed both alike consist of two shared electrons.

The further application of these ideas to those compounds with which Werner's name is most closely connected is an inquiry of

great interest, but I do not propose to pursue it here. I would rather consider some more general questions. We have been led, in seeking an explanation of the structure of coordination compounds, to the conception of a third form of atomic linkage in addition to the recognised forms of electro-valencies and co-valencies; or, as we should rather say, we have found that a covalency can arise in a second way. This new method is peculiar in that it allows of the combination of apparently saturated atoms or molecules with one another, and it is therefore the condition which makes the association of liquids possible. Links of this type are not confined to inorganic compounds, but are widely spread in organic chemistry, as Werner himself showed. Co-ordination is thus of great importance throughout the whole of chemistry. Now that we understand the physical mechanism which underlies it, we may hope to arrive at some idea of its characteristic properties, and it will be well to consider what new light these throw on various problems of chemistry in general.

We have already seen that the formation of a co-ordinate link involves the presence of one atom which can act as a donor and another which can act as an acceptor. The donor must have a pair of unshared valency electrons. The acceptor must have fewer valency electrons that it is capable of holding. This raises the question of the maximum size of the valency group. If we maintain the original octet theory, that the valency group cannot exceed 8, and at the same time hold that every covalency involves two shared electrons, it follows that the maximum covalency cannot exceed 4. The existence of stable compounds such as sulphur hexafluoride shows that this conclusion is false, and hence that one or other of the two assumptions must be abandoned. Some chemists maintain the octet limti, and explain the eristence of atoms with a covalency greater than four by assuming the possibility of a covalent link formed of a singl e shared electron : they suppose, for erample, that in sulphur hexafluoride the sulphur has eight shared electrons, and that two of the fluorine atoms are attached by two electrons each, and the other four by one each. This view seems to me to be untenable. There must be some relation between the mechanism of a link and its behaviour; if not, it is of little use to discuss the mechanism. Links of single electrons undoubtedly occur in a limited number of compounds of hydrogen, such as $[H_2]^+$ and the hydrides of boron (H_2H_6, etc); but, as we should expect, they are always very unstable. I cannot believe that a substance like sulphur hexafluoride, which is one of the most stable of known compounds, and can be heated to a red heat with sodium without decomposition, can contain four such links. I should therefore abandon the limit of 8 for the valency group (as G. N. Lewis has now done), and adhere to the view that in all but a few unstable compounds every covalency involves two shared electrons. On these principles the maximum size of the valency group is twice the covalency or co-ordination maximum. An examination of the structures of known compounds gives strong reason to believe that there is a direct and simple relation between the maximum covalency (co-ordination number) of an atom and its position in the periodic table, and that this depends not on the periodic group but on the period in which it occurs, so that the co-ordination classification runs horizontally, while the normal valency values, as we all know, run vertically. It would take too long to discuss the evidence for this statement, but I may give the conclusions. The maximum covalency of hydrogen is 2 : that of elements in the first short period (lithium to fluorine) is 4 : that of elements in the second short period (sodium to chlorine) and the first long period (potassium to bromine) is 6 : and that of the later elements is 8. The maximum number of electrons in the valency group is, of course, twice as great, being 4, 8, 12, and 16, respectively. No physical reason for these facts can as yet be given, but a certain relation can be traced between the numbers and those in the grouplets of the Bohr theory as modified by Stoner and Main Smith.

The next question is the difference in properties which is to be expected between the normal and co-ordinate covalencies. These are essentially of two kinds. In the first place the co-ordinate links are in general less stable. The stability of a link depends on the work required to break it, or, in other words, on the difference of energy content between the original molecule and the products of the rupture of the link. Hence, the more unstable these products are, the more difficult it is to break the link. The rupture of a normal covalency leads to the production of two univalent radicals

$$A : B \longrightarrow A^{\cdot} + {}^{\cdot}B$$

that is, of two highly unstable products. But a co-ordinate link can break by the return of the two shared electrons to the atom to which they originally belonged

$$A : B \dashrightarrow A \quad : B$$

and one at least of the products is now a molecule capable of independent existence. Thus, the products of the rupture of a co-ordinate link are, as a rule, more stable than those formed by breaking a normal co-valency, and the co-ordinate link is therefore less stable. This difference is particularly marked in rings containing co-ordinate links, those which Prof. Morgan has called chelate rings: these are far more sensitive to strain, owing to the weakness of the co-ordinate link, than the ordinary rings of organic chemistry; while the latter are known of every size from three to eighteen members, chelate rings almost invariably contain either six or five; a few 4-ring are known and one or two 7- and 8-rings; but none with less than four or more than eight members. This explanation of the difference in strength between normal and co-ordinate links is of considerable importance; the fact is beyond dispute, and if we are to maintain that the mechanism of both forms of linkage is the same, consisting in the sharing of two electrons, we must be able to give a reason for this difference in stability.

The second point of difference is that while the normal covalency involves no considerable disturbance of the electrostatic equilibrium in the molecule, this is not true of the co-ordinate link. In the normal link between two atoms, each atom shares one electron with the other atom. If the electrons were shared equally between the two there would be no electrostatic disturbance at all. We do not know enough about the dynamics of the sharing of electrons to say how nearly this is true, but the properties of ordinary covalent compaunds indicate that it is not far from the truth, and that the shared electron usually divides its time more or less equally between the two atoms which share it. But when a co-ordinate link is formed between two originally neutral atoms, one of them loses and the other gains a share in two electrons. Hence, the acceptor must receive a negative charge from the link and the donor a positive charge. This fact is expressed by some chemists, such as Prof. Lowry, by writing the link $\overset{+}{A}-\overset{-}{B}$ instead of $A \rightarrow B$. A molecule containing such a link is therefore an electrical dipole. This electrostatic disturbance will have two chief results: it will increase the dielectric constant of the substance, and it will increase the attraction of the molecules for one another, and therefore diminish the volatility. That this does actually occur we have plenty of evidence; I may give a few examples, selected from non-associated substances, in order to avoid the complications which associations might produce. While the value of the dielectric constant for hydrocarbons is about 2-3, for ethers about 4, and for esters about 7 (all these being free from co-ordinate links), it is greatly increased by the introduction of a nitro-group,

$$-N \genfrac{}{}{0pt}{}{\nearrow O}{\searrow O},$$

which contains this link, and is for nitromethane 39 and for nitrobenzene 36. The effect on the boiling point is seen by comparing the alkyl nitrites $R-O-N=O$ with the isomeric nitro-compounds

$$R-N \genfrac{}{}{0pt}{}{\nearrow O}{\searrow O}:$$

the latter boil from 50° to 100° higher than the former. Many other examples might be quoted.

These examples suggest the consideration of associated liquids. As long as we were at liberty to invent new kinds of subsidiary valencies, the existence of association caused no tronble. But now that we claim to have discovered the mechanism of atomic combination, we must identify the link between the molecules of an associated substance with one or other of the forms of link that we have recognised, and it is evident that the co-ordinate link is the form required. We ought therefore to be able to find in every associated substance a donor and an acceptor atom. Such atoms are always found to be present: in the most familiar class if associated compounds, those containing hydroxyl groups, the oxygen atom of this group, with its two pairs of unshared valency electrons, is the donor, and the hydrogen atom, being able as we have seen to increase its valency group from two to four, is the acceptor. We thus get the possibility of an indefinite degree of polymerisation:—

```
          H         R        O
         /         /        /
R——O——>H-----O——>H-----O——>etc.
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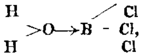
That the association does depend on the two atoms of the hydroxyl group is shown by the fact that if we replace either the oxygen by sulphur or the hydrogen by an alkyl group the association disappears; neither the mercaptans nor the ethers are associated. Associated substances possess the propertie swhich we have seen to accompany the co-ordinate link, the high dielectric constant and the low volatility. The latter property is commonly taken to be snfficiently explained by the rise of molecular weight which the association prodnces, but unless this is much greater than we have any reason to suppose, it will not account for the whole effect. For example, the ethers boil about 60° lower than the corresponding thio-ethers; hydrogen sulphide boils at 61°, and so unimolecular H_2O should boil about - 120°. If the real formula of water is H_6O_3 (and it is very improbable that its average polymerisation is even as great as this at 100°), its true molecular weight is not 18 but 54. This will account for a rise in the boiling point, but not for so large a rise as is actually found. Hydrogen selenide (mol. wt. 81.2) boils at - 42°, and butane (mol. wt. 58) at + 1°. Evidently the polymerised molecules themselves are much less volatile than corresponds to their molecular weights, as we should expect from the presence of the co-ordinate link. The high values of the dielectric constant (water, formamide, and hydrogen peroixde about 80, methyl alcohol, 35, ethyl alcohol 27) are further evidence of co-ordination. This reference to the dielectric constant raises a point which is worth mentioning, although I cannot discuss it in detail here. In some modern developments of the theory of organic reactions great stress is laid on the dipole moment of such groups as hydroxyl. The values of these moments are calculated from the dielectric constants of the hydroxylic compounds, and we are assumed to apply to the single unassociated molecules. Now since we have seen that the association itself must increase the dielectric constant owing to the co-ordination of the molecules with one another, it is by no means certain that values so obtained hold good for the unpolymerised hydroxyl group. It is, of course ,quite possible that the same conditions which make the hydroxyl group so ready to polymerise also give it a high dipole moment even in the simple molecule; but the rise in the dielectric constant which the association itself must produce is a factor which must be taken into account, especially as it is one which will vary with the temperature.

This view that association is due to co-ordination throws light on the behaviour of a group of substances whose position was hitherto rather puzzling. There are many substances such as sulphnr dioxide, ethers, and amines which behave in many ways like associated liquids, and yet when they are directly tested are found not to be associated; they ae volatile, and give simple values of the molecular weight in the pure state and in non-associated solvents. It has long been a problem how such substances should be classified. It is now clear that they contain only one of the two elements necessary to co-ordination; they have donor atoms (oxygen or nitrogen) but no acceptor atoms (the acceptor properties of hydrogen attached to nitrogen are for some reason very weak). They are thus incapable of polymerisation, and in the presence of non-associated liquids they behave as normal non-associated substances. But in the presence of a substance capable of association, and so containing acceptor as well as donor atoms, they behave as associated substances.

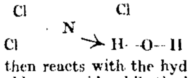
These considerations emphasise a very important and far-reaching characteristic of the co-ordinate link, its one-sided nature. The two atoms taking part in it perform quite different functions; and in determining the structure of a co-ordination compound it is essential to show which of the two co-ordinated atoms is the doner and which the acceptor. This distinguishes the electronie view of co-ordination from the subsidiary valency theory of Werner and his school; there was no apparent reason why two atoms which could form subsidiary valencies with a third atom should not also form them with one another. We can see now that such a linkage is impossible: there must be the necessary opposition in character between the two atoms before co-ordination can take place. It is true that Wern erhimself was saved by his almost uncanny insight into molecular structure from falling into this error, but there was nothing in his theory to save him from it, and not all his followers had as true an intuition as he had himself. The recognition of this distinction ,to which the electronic interpretation directly leads, is a definite advance.

Among the more important developments of the theory of co-ordination which must be expected in the near future, its system-

atic application to organic chemistry must take a high place, for it is by the study of organic compounds that we really can examine in minute detail the influence of structur eon properties. The very existence of organic chemistry—the fact that the compounds if carbon form a group at least as numerous and important as all other chemical compounds together—can only be fully explained by reference to the theory of co-ordination. Werner pointed out long ago that the unique position of carbon was due to the fact that its valency and its co-ordination number were identical. This we should now express by saying that as it has four valency electrons it can obtain a fully shared octet by normal covalency formation and without the production of co-ordinate links. But this is not all. Since carbon is in the first short period of the table ,this octet is incapable of further expansion. Hence the ordinary saturated quadrivalent carbon atom is incapable of acting either as an acceptor or as a donor, and for this reason it is peculiarly well protected from the attack of other atoms. This is undoubtedly the chief cause of the remarkable sluggishness (Trägheit, as Victor Meyer called it) so characteristic of carbon, a disinclination to react which gives comparative stability to a large number of thermodynamically unstable compounds. That this explanation is sound may be seen by comparing the behaviour of the halides of carbon with that of the halides of neighbouring elements. Most non-metallic halides are readily hydrolysed by water, and we may assume that the hydrolysis is preceded by a combination (through the formation of co-ordinate links) of the water with the halide. In boron trichloride, for example, the incomplete octet of the boron completes itself by sharing a pair of electrons from the oxygen of the water, forming the compound



analogous to the ammonia compound discussed above. A hydrogen and a chlorine atom then separate as hydrochloric acid, leaving a hydroxyl group attached to the boron, and by the repetition of this process the hydrolysis to boric acid is completed. The same reaction occurs with silicon tetrachloride, because, although the silicon has already a complete octet, it can expand this to a group of 12, since it is in the second period. With nitrogen the position is not quite the same. In the trichloride NCl_3 the octet of the nitrogen is complete, and it is incapable of expansion; but it is not fully shared, and contains a lone pair of electrons. Hence, though it cannot be an acceptor, it can be a donor. It forms a co-ordinate link not with the oxygen but with the hydrogen of the water, giving



The chlorine then reacts with the hydroxyl, forming hypochlorous acid, while the hydrogen remains attached to the nitrogen, the ultimate product being ammonia. The truth of this hypothesis of intermediate co-ordination with the water is strongly supported by the fact that it explains the unusual production of hypochlorous acid from chlorine attached to trivalent nitrogen.

But carbon tetrachloride cannot react in either of these ways. It has a complete octet, and cannot increase it, and the octet is fully shared, so that it cannot act as a donor. It therefore does not react at all. The remarkable inactivity of carbon tetrachloride has long been regarded as an unexplained anomaly, but we can now see that it is a necessary consequence of the theory of co-ordination. If we want to find a similarly inactive halide of an element in a later period, where a valency group of 12 is possible, we must obviously choose one in which this group of 12 is fully shared and also is incapable of further expansion. Examples of this are the hexafluorides of sulphur and selenium, whose inactivity is as remarkable as that of their carbon analogue. Tellurium hexafluoride on the other hand is hydrolysed by water, since its valency group of 12 can expand to 16, and the tellurium can therefore (like silicon in the tetrahalide) act as an acceptor.

Now the carbon atoms in an ordinary saturated organic compound all resemble that in the tetrahalide in having fully shared valency groups of the maximum size. They are therefore incapable of the most obvious form of reactivity, which begins by co-ordination with a reagent molecule : if they are to react at all, it must be through some other atom in the molecule. Is a significant fact that one of the most elementary rules of organic chemistry is that a carbon atom united only to other carbon atoms or to hydrogen or the halogens is very slow to react but that the introduction of a single oxygen atom into the molecule facilitates reaction. The comparison of the paraffins

with the ethers or alcohols, of the ethers with the esters and the esters with the acid anhydrides, or of the alkyl halides with the acyl halides, illustrates the effect which an oxygen atim may have on the stability of a molecule. It seems natural to relate this effect to the strong donor properties which oxygen exhibits, and to suppose, for example, that the rapid hydrolysis of an acyl halide is due to the formation through the oxygen of a compound

$$\begin{array}{ccc} & O \longrightarrow H & \\ R\cdot C & & O, \\ & Cl \quad H & \end{array}$$

in which the hydrogen of the water is brought into close proximity with the chlorine, while the relative inactivity of an alkyl halide is the result of its inability to form such a compound.

I make these suggestions (which might easily be extended) because it seems to me that in the intensive modern study of the influence of structure on the reactivity of organic compounds this side of the question has been too much neglected. Great attention has been devoted to the consideration of the effect of other atoms in the molecule on the strength of a particular linkage. A new mechanism and a new terminology—or perhaps more than one—have been invented to account for the results. This mechanism is described in terms of physical concepts, and although it appears to me that the properties which are assigned to these concepts need considerable modification before they can be accepted by the physicist, there is no doubt that this mechanism enables its inventors to correlate a large number of important generalisations, so that some real truth must underlie it, although we may at present be in some doubt as to what truth exactly is. But I think these chemists have tended to rely too much on supposed modifications of the linkages within the molecule, and have not sufficiently considered the possibility of the formation of co-ordination compounds with the reagents employed, such as those which I have suggested above. The effect of one atom in a molecule in hastening the replacement of another may not be due merely to a weakening of the attachment of the latter, but may be caused by the formation of co-ordinate link through the former, or this may promote co-ordination through some other atom in the molecule. We know now that even in purely 'organic' compounds—quite apart from those organo-metallic compounds which the old-fashioned organic chemist regarded with so much abhorrence. In the particular form of the production of chelate rings, that is, in the form of co-ordination between two atoms of the same molecule, it has been shown to occur in β-diketones and β-ketoesters, in many ortho-substituted phenols, and in α-ketoximes, and to be responsible for much of the chemical as well as the physical peculiarities of these substances; and in the more general form of association or 'molecular compound' formation its occurrence is widespread. Formerly the production of such compounds was ascribed to some inferior and rather contemptible form of valency, possibly to a force acting not between atoms at all, but between whole molecules, and so the influence of their formation on what were regarded as the reactions of genuine valencies was naturally taken little into account. But we now realis ethat they owe their existence to the production of co-ordinate links, and that the co-ordinate link is in essence the same as a normal co-valency. The co-ordinated hydrogen, for example, as in

$$H-O-H \leftarrow O <^{H}_{H} ,$$

is attached to each of the two oxygen atoms by means of two shared electrons. The link on one side is just as genuine as that on the other, although, owing to the difference in the states of the two oxygen atoms, one of them may separate more easily. It therefore seems probable that the formation of such a link may often be a preliminary stage to the complete transference of the hydrogen from one point of attachment to another, and that the possibility of its formation may be a necessary condition of reaction. We have further to recognise another way in which reaction may be promoted by co-ordination, which is illustrated by the example I gave of the hydrolysis of an acid chloride. The formation of a co-ordination compound between two molecules may bring two atoms into proximity with one another, and so favour their reaction. In developing this possibility we have to consider the stereochemical relations. The study of chelate rings has shown us what forms of ring are most stable; owing to the weakness of the co-ordinate link which they contain such rings afford, as I have already pointed out, a more delicate test of strain than the ordinary rings of organic chemistry. Thus we find that a chelate ring of six atoms, including double links, is formed with peculiar ease. From this we may conclude that when a chain of

cludes one or two double links, the sixth atom of this chain will be able to approach the first very closely, and so may be expected to react with it. In these and other ways the consideration of possible intermediate co-ordination products may provide the clue to many organic reactions.

If this line of thought is to be pursued, there is a preliminary question which requires investigation. We have seen that two conditions are essential to the formation of a co-ordinate link, the presence of an atom with an unshared pair of valency electrons (the donor), and of another (the acceptor), which can add two electrons to its valency group. But these conditions, though necessary, are not sufficient. They are both fulfilled in most organic molecules other than those of hydrocarbons. The normal hydrogen atom has only two electrons, and it can hold four : every halogen atom, every oxygen atom, every trivalent nitrogen atom has an unshared pair of valency electrons; and yet halides, ethers, and amines are not as a rule associated. For co-ordination to take place it is necessary not only that such atoms should be present, but also that they should be so linked that they are able to exercise their donor or acceptor properties. Hydrogen, for example, is a powerful acceptor when it is joined to oxygen or fluorine; it is a weak acceptor when it is joined to nitrogen; it is practically not an acceptor at all when it is combined with carbon or one of the heavier halogens. We cannot at present explain these differences in behaviour, but it is quite easy to show that they exist. In the saem way the donor properties of oxygen are very largely influenced by its state of combination. If the influence of co-ordination on reactivity in organic compounds is to be studied in detail, the first necessity is a knowledge of the factors which promote co-ordination itself ,and this can only be attained by a careful examination of the facts from this point of view; a thorough investigation of the influence of substitution on the tendency of molecules of a particular type to associate with themselves, or to form addition compounds with other substances, would no doubt throw much light on the question. It would be particularly interesting to know what is the effect on activity, both in donors and in acceptors, of the peculiar tendencies to reaction which the modern organic chemist represents by positive and negative signs.

I have tried in these remarks to emphasise the fact that the modern electronic interpretation of the theory of co-ordination has a value far outside the range of those compounds which the theory was originally devised to explain. There is too great a tendency even now to regard the question of co-ordination as one which is of interest only in connection with a highly special group of substances which the ordinary chemich rarely meets, whereas in truth the study of this question has given us a wider and a truer conception of the nature of the processes by which molecules are built up. The determination of the factors which influence chemical reaction is perhaps the most important of the fundamental problems of chemistry, and it is essential that the factor of co-ordination, with the new possibilities of reaction-mechanism which it opens up, should be recognised and investigated."

A SELECTIVE DISPLACEMENT OF 0.0153A IN X-RAY SPECTRAL LINES.—ADDENDUM. PART X.

By F. H. Loring.

Owing to some very recent work of high order by Aston, Hönigschmid, Wolf, and others, bearing on the subjects of this study, it is suggested that the following addendum may be of interest.

Where, as below, words are in italics, it does not necessarily mean that they are intrinsically important, but that the idea they convey should not be overlooked in forming a critical opinion of the matter under development. The writer is critically disposed in these matters.

In Part IX an attempt was made to calculate the atomic weight of silver, the constants employed being correlated by using the displacement constant Δ_a as a sort of standard for final adjustment.

Recent work on silver calls for some further observations and a revision of the 'silver calculation'; or, at least, *one that may be taken as an alternative*. This is given below. A list of page references to the writings on the subject by the present author is placed at the end of this study.

Consider the atom to be divided into two mass components, one (1) the *protonic mass*, being the mass of one and all the protons in the atom, designated thus : H_{pm}, or He_{pm}, for example; the other (2), the *electronic mass*, being the mass of one and all the electrons in the atom, represented

thus : H_{em}, or He_{em}. If these masses are expressed in terms of atomic weight, oxygen 16 exactly, then the symbols can be further expanded thus : H_{pma}, H_{pma} H_{ema} He_{ema} otherwise the masses would be in grams.

If now the ratio, H_{pma}/He_{pma} = 0.25194, keeping to the value already given, then He_{pma} = 3.99796, when H_{pma} = 1.007246. Just here the finer adjustment is somewhat arbitrary.

The mass of the electron on the atomic-weight scale (O = 16) is H_{pma}/1847.087 = 0.0005453. This will be understood from the *previous part* (IX). Since H has *one* electron only its atomic weight should be made up thus : 1.007246 + 0.0005453 = 1.0077913.

F. W. Aston has now arrived at the atomic weight of hydrogen, *viz.* : 1.00778 (see Aston, Bakerian Lecture, *Roy. Soc. Proc.*, A, 1927, cxv, 487). The above-calculated value agrees very well with Aston's value and with those determined gravimetrically, and gasometrically so to speak. Thus the calculated value seems to be within the range of experimental error.

In the case of helium, this makes up as follows : He_{pma} + (4 × 0.0005453) = 4.000141, being the atomic weight of the neutral helium atom. Aston (*loc. cit.*) arrives at the value 4.00216. G. P. Baxter and H. W. Starkweather (*Nat. Acad. Sci. Proc.*, 1926 xii, 20), from density determinations had obtained the value : 4.000, which they considered to be accurate up to—but not including—the 4th decimal place, as shown.

In the case of the silver calculation as given on page 66 of the *Chemical News*, 1927, cxxxv, the views above seem to make it necessary to revise the procedure, especially as a basic value (0.25194) is figured from the protonic masses. Keeping to this value, and instead of introducing the atomic number in terms of electrons, the total number of electrons is taken; as any value based upon protonic masses is not complete from the point of view of atomic weight, which is an inclusive term; therefore, the total electronic mass must be added to get a finished value. This means that the value for the electron—its atomic weight—has to be multiplied by 107.82. The following equation (split into two parts, owing to the lengthy figures used) shows the full calculation:—

$$[(9569.0583)/(1/0.0111805)] \times (1.0077913) = 107.820427 = a.$$

$$a + (0.0005453)\ a = 107.87922.$$

It will be seen that the electrochemical equivalent is taken a very little higher than the standard fixed value 0.011180. In fact it is a mean value obtained by adding three published values (0.01118, 0.011179, 0.0111826) and dividing the sum by 3. This may be a little arbitrary, but it is the best that can be done.

O. Hönigschmid, E. Zintl and P. Thilo (*Zeit. für anorg. und allegm. Chemie*, 1927, clxiii, 65) in a redetermination of the atomic weight of silver obtain the value 107,879. This value and the one above are practically the same. At any rate the method of calculation gives a satisfactory result in this case. There is, of course, the danger of a chance coincidence, as the method of calculation involves some hypothesis.

Attention may be drawn to a very recent paper by F. Wolf (*Annalen*, 1927, lxxxiii, 849) on the redetermination of the e/m constant. The method of measurement involves the procedure of H. Busch (see *Phys. Zeit.*, 1922, xxiii, 438), whereby magnetically deflected cathode-rays in longitudinal field are measured simultaneously with the discharge potentials. Wolf's concordant measurements lead to a final value $1.767_9 \times 10^7$, which suggests that the present writer's value, 1.767488×10^7, is about correct—if no factors are involved in either instance which would make the comparison not a fair one.

The following table shows all the values under discussion here. It will be seen that a few of these differ slightly from those previously given—see Parts VIII and IX.

(23)	At. wt. of electron	0.0005453.
(24)	At. wt. of electron (Aston)	0.00054 ...
(25)	At. wt. of H	1.0077913.
(26)	At. wt. of H (Aston) ...	1.00778.
(27)	At. wt. of He (Aston) ...	4.00216.
(28)	At. wt. of He	4.000141.
(29)	At. wt. of He (Baxter and Starkweather)	4.000 . . .
(30)	At. wt. of Ag	107.87922.
(31)	At. wt. of Ag (Hönigschmid, Zintl & Thilo)	107.879.
(32)	H_{pma}	1.007246.
(33)	He_{pma}	3.99796.
(34)	H_{pma}/He_{pma}	0.25194.
(35)	Electrochemical equivalent of Ag	0.0111805.
(36)	e/m (Wolf)	$1.767_9 \times 10^7$.
(37)	e/m	1.767488×10^7.

Atomic weight on the O = 16 basis. The higher values *precede* those that are comparative, for easily noting differences.

In Sommerfeld's "Atomic Structure and Spectral Lines," 1923, p. 528, the following *fine-structure* constants are given :—

α = (7.295 *plus* or *minus* 0.005) × 10^{-3}

α^2 = (5.322 *plus* or *minus* 0.007) × 10^{-5}.

Δ_H = 0.3650 *plus* or *minus* 0.0005

In these studies the corresponding values are: 7.3003709; or with smaller π: 7.2953024. The squared values are 5.3295415 and 5.3221437, respectively, with of course the multipliers as above.

Δ_H then becomes 0.3660386 by equation; or 0.3660396 from Δ_a, as already given. Using smaller π :—

(38) π_s = 3.1394115, whereby

(39) Δ_H = 0.3650232, and

(40) $(e/m)/(2\pi_s)$ = **2815000.**†

Using the values for h, e and c as before‡ in these studies the following obtains :—

(41) h/e = 1.37197. × 10^{-17} erg sec. E.S.U.$^{-1}$.

(42) $hc/(e \times 10^8)$ = 4.11312 × 10^{-15} volt sec.

(43) hc^2/e = 12,330.986 volt Angstrom.

(44) $(e \times 10^8)/(hc^2)$ = 8109.65 volt.$^{-1}$ cm.$^{-1}$

(45) Energy of electron falling through 1 volt **1.593** × 10^{-12} erg.

(46) c^2/h = **3.4833** × 10^7.

In considering the *Bohr magneton* relative to the *Weiss elementary magnetic moment* (Weiss magneton) the value may be derived from the equation :

(47) $(e/m).(h/4\pi_s).L$ = 5592.476 gauss × cm.

This value divided by 4.97 should perhaps give the Weiss value as recently determined, namely, 1126 (see P. Weiss, *Journ. de Phys.*, 1924 v, 129). It comes out at 1125.43 when L is 6.061 × 10^{23}; but, although to be consistent, π_s has to be taken. It seems necessary to use the above value for Avogadro's constant as it appears to be used in connection with the comparison value 1126. 6.062 would give a value 1125.61, while the lower value 6.002857 (see 22) would give the value 1114.63. Using 4.97 instead of 5 simply means that the former value is the one used in this connection, but so far as the writer is aware it is not an absolute value. It comes to this. With the values deduced in this study the magnetic moment is not appreciably different from the latest published value when the calculations are made on a proper *comparative basis*.

* See article following this : "The Use of π in Atomic Optics."

† Heavy-face numerals merely indicate that the value appears to be exact as given.

‡ See (5) (7) (8) in Part VIII.

REFERENCES.

Chemical News, 1926, cxxxii, 101; 1927, cxxxiv, 65, 97, 129, 130, 193, 291, 321, 385; 1927, cxxxv, 17, 65, and "The Use of π in Atomic Optics" to appear later.

GENERAL NOTES.

ELEVENTH EXPOSITION OF CHEMICAL INDUSTRIES.

(*Grand Central Palace, New York, September 26 to October 1.*)

The history of the United States is replete with occurences where in cases of emergency industry has stood in the foreground, *carrying the burden and supporting the* country in the hour of need. The particular outstanding instances are the dye and the nitrate industries, just prior to the declaration of war the United States on Germany and her Allies where a condition existed that created a very serious problem in the supplying of the necessary chemicals for use both by the Government and industry in this country. Such conditions could not have been met and surmounted if it were not that chemistry and chemical engineers had always been just a step ahead in the methods and advanced processes of chemistry in this country.

Prior to the World War, the chemical industry was more or less in a stagnant state. Most of the principles developed in chemistry had come from foreign sources and industry depended almost entirely on this field for the necessary materials and finished products that were required. With the declaration of war in Europe and the increased demand for raw and finished products the industries in the United States were suddenly confronted by the importance of chemistry and chemical engineering *products necessary for their existence.* Branches of this industry sprung up over *night and before the end of the war the* scope of the chemical industries in the

development and manufacture of crude, raw, and finished products, or satisfactory substitutes could be produced in this country by domestic industry thereby conclusively proving the part played by chemists and chemical engineers has never been so prominent as it is to-day. It is impossible to name any form of industry or life in the civilized world that has not been affected and beenfited by this science, and the developments that have been brought abount through research and tireless effort on the part of the far-sighted leaders of this industry has proved beyond any argument the fact that this industry when aroused can produce either raw or finished materials or satisfactory substitutes in emergency.

Of further interest is the programe as outlined for the students' course that is annually conducted in connection with the Exposition of Chemical Industries. Leading educational institutions are sending both students and members of their faculty to attend the Exposition both for the lectures during the students' course and the Exposition where a careful study of exhibits and practices will be discussed and in many cases, demonstrated.

One of the many interesting features of the Exposition will be exhibits of Stainless Steel and Iron in the alloy section. These exhibits will contain the latest developments in this branch of the alloys and the leaders will be the Central Alloy Steel Company, Vanadium Corporation of America, and the International Nickel Company. The appearance of fabricated stainless materials dates back only as far as 1912. The Krupps exhibited at the Gothenburg Exposition that year certain stainless articles of commerce manufactured from their highly alloyed nickel chome steels. It has been only very recently that stainless steel has come to be far more prominent than in any other period in its history. However, constant research is rapidly overcoming the various obstacles in this field and the industrial importance of this alloy is evidenced by the long list of patents in this country of the smaller malleable varieties rather than the steels. Industrial importance in rust resisting sheets cannot be too strongly stressed because of the protection afforded by such alloys. This is particularly effective in food containers, chemical reaction towers, milk coolers, and acid drums. Much interest is already being manifested in the alloy section. Along with the new alloy exhibits, the Brown Instrument Company is exhibiting a new electric flow meter with an unusual basic principle and other special features of great precision and measurement are used. Brown Instrument Company reports that for the first time with a flow meter operating on the self balancing inductance bridge principle they are able to accurately indicate and record flow changes at any distance between the manometer and connected instruments, without step resistances, make and break contacts, permanent magnets, voltage regulators, compensators, electrical parts in the pressure chamber or stuffing boxes. A full line of Brown Instruments of Measurement and Precision will be exhibited at the coming Exposition of Chemical Industries. The management reports that the Exposition will reach a point as nearly perfection as possible and with the long list of exhibitors of domestic products this year for the first time in the history of the Exposition, there will be a number of foreign exhibits of great interest to all industry. The United States Government will have two very interesting exhibits. The National Safety Council will present in complete form the recently concluded exhaustive study of benzol and the toxicity of this solvent where used in products designed for manufacturing and domestic use. This is only one of the features of the 350 exhibits that will be displayed at the Grand Central Palace, September 24 to October 1, 1927, during the Eleventh Exposition of Chemical Industries.

EFFECT OF WORK AND ANNEALING ON THE LEAD-TIN EUTECTIC.

By F. Hargreaves, A.R.S.M., D.I.C., F.I.C., Member.

(Before the Institute of Metals.)

Synopsis.

A marked softening action of work at air temperature on the lead-tin eutectic is found and the effect of different degrees of working is investigated. In the case of 78 per cent. reduction in thickness, the Brinell hardness is reduced from about 14 in the chill-cast condition to 4.2 when tested immediately after hammering. This value is actually lower than that of either constituent in the pure state. Annealing at air temperature and at 100° C. for different periods is carried out, and the effect on the rate and extent of recovery in hardness

determined. Finally, the effect of annealing at just below the melting point is recorded. Little micrograph work is recorded. Reference is made to the relationship of well-known phenomena to the results obtained.

JAMES WOODHOUSE, 1770-1809.

A BIOGRAPHY BY EDGAR F. SMITH.

Although he died at the early age of 38, James Woodhouse, a pioneer in American Chemistry, had a very active career extending from 1795 to 1809—a very critical period in the history of our science.

Prof. Smith in his biography (published by the John C. Winston Co., Philadelphia), gives a true picture of chemical science in America during the epoch when Woodhouse flourished. The number and variety of the investigations which this chemist successfully undertook is astonishing and readily accounts for his being the outstanding figure in American chemistry for the last decade of his life. He materially helped to establish correct views of the phenomena of combustion and respiration, and also showed the composition and decomposition of water. He isolated potassimu from potashes by a novel method in 1808, and also carried out investigations in plant and industrial chemistry and analysed many minerals.

He also published several books, the most important being a laboratory handbook in which he emphasised the necessity for practical work if proficiency in science is to be attained.

The excursions of Prof. Smith into the realms of science are always interesting, and this is no exception.

J. G. F. D.

GAS UNDERTAKINGS IN GREAT BRITAIN.

Part I. of the Return relating to Authorised as Undertakings in Great Britain for the year 1926 has been issued by the Board of Trade (published by H.M. Stationary Office; price 5s. net). This part contains particulars of the gas manufactured and sold by the 784 authorised undertakings. Part II., which will be issued later, will contain particulars of the finance of these undertakings and of the prices charged for gas.

The Return gives particulars of the make and consumption of gas, materials used, quantities of residuals made, number of consumers, etc., for each of the 784 undertakings. For those concerns which were authorised to charge on the basis of heat units supplied, the quantities of gas sold are shown in therms as well as in cubic feet. In cases in which an officially ascertained calorific value is available, the quantities made are also shewn in both measurements.

PRODUCTION OF CHEMICALS IN 1925 IN JAPAN.

The number of chemical factories in Japan was 2,498 at the end of 1925, number of persons employed in those factories was 123,063, and amounts of fuel used in the year were: coal 3,587,695,923 kin (about 2.13 million tons), coke, 82,287,597 kin (about 49 thousand tons), petroleum 306,532 koku (about 55 thousands cbms), gases 594,196,657 cft., and wood charcoal 5,472,909 kwan (about 20 thousand tons). Electric power consumed was 1,029,276,906 kwh.

The following figures for the chemicals produced were taken from the official report recently published:—

Sulphuric acid ...	1,156,151,029 lbs.
Hydrochloric acid ...	51,549,808
Nitric acid	15,929,936
Sodium sulphate ...	63,927,579
Sodium carb. crystal	1,910,862
Soda ash	24,607,824
Caustic soda	56,048,164
Potassium chloride...	1,558,287
Potassium nitrate ...	428,810
Iodine	35,717
Potassium iodide ...	95,737
Alum	7,405,262
Aluminium sulphate	32,753,449
Bleaching powder ...	81,826,480
Acetic acid	8,759,447
Tannic acid	208,400
Carbolic acid	18,236
Calcium acetate ...	683,700
Acetone	475,635
Methyl alcohol ...	1,152,108
Glycerine	2,666,450
Zinc white	14,238,557
Litharge	1,396,079
Red lead	10,923,737
Barium sulphate . .	3,875,230
Lithopone	3,104,756
Lead white	173,600
Carbide of calcium ...	76,509,793
Carborundum ...	669,834
Ammonium sulphate	
Superphosphate ...	188,967,806 kwan.
Potassium sulphate	213,940 kwan.
Lime-nitrogen ...	13,243,072 kwan.

THE ACID INDUSTRY IN CANADA.

A nation's consumption of sulphuric acid is often regarded as a barometer of its prosperity. The first sulphuric acid plant in Canada was erected at London, Ontario, in 1866, the year before Confederation. To-day there are seven plants manufacturing this commodity; one plant in Nova Scotia produces acid for local use in neutralising the by-product ammonia from the coke plant; three in Ontario and two in British Columbia make sulphuric acid, one of the latter using a considerable amount in the manufacture of fertilisers; another plant in British Columbia makes its own acid for use in metallurgical processes in the treatment of zinc ores. In 1925 considerable interest was manifested in the manufacture of sulphuric acid by the contact process from waste sulphur dioxide gases from the metallurgical works in the Sudbury district, where it was estimated that 500 tons of sulphur a day were discharged into the air. Towards the end of 1926 the capacity of the plant erected for this purpose was doubled to meet the demands.

In 1925, according to the Dominion Bureau of Statistics, the production of sulphuric acid amounted to 166,791,926 lbs. of 66° Be. acid. Exports have been steadily increasing and in 1925 totalled 38,358,600 lbs.

JOURNAL OF THE BRITISH SCIENCE GUILD.

6, John Street, Adelphi, London, W.C.2.

The issue for July, Number 23, gives a review of the various activities of the Guild during 1926, including Report and Balance Sheet. There is also given a summary of the meeting of the British Association at Manchester in 1842. That dealing with Chemistry was as follows:—

" The most interesting communication made in chemical science was Professor Liebig's report on organic chemistry, applied to physiology and pathology. The mere consideration of such a subject opens a new and wide field of inquiry. The report contained a vast number of curious and remarkable facts, many of which apply themselves to the interests of every one, and to the daily occurrences of life. In theoretical chemistry we may rank Professor Schönbein's communication on the electrolysing power of a simple voltaic circle; the result of various experiments made by the author going to establish the fact that voltaic effects may be produced without the solution of a metal, the usual source of voltaic actions, but by nitric and other acids. Also Mr. Joules' communication, in which he endeavoured to account for the heat evolved by the combustion of certain bodies, on the hypothesis of its arising from resistance to the conduction of electricity between oxygen and the combustibles at the moment of their union. Another interesting communication in chemical philosophy was Mr. Mercer's attempt to explain, on ordinary chemical principles, some effects hitherto described as catalysis. Perhaps the most important communication in practical chemistry was that of Dr. Playfair, in which he made known certain new oxides of metals of the magnesian family. This memoir was of high importance to chemical geology. Next came three papers by the venerable Dr. Dalton, who was the lion of the Manchester meeting, on phosphates and arseniates; on microcosmic salt, and on a new and easy method of analysing sugar. There were also papers on the influence of light on the germination of seeds, by Mr. Hunt; on the modes of production of sulphuric acid, by Mr. Blyth; on agricultural chemistry, by Dr. Daubeny!; on Kakodylic acid, by Mr. Bunsen; and several others of practical importance.

BELGIAN TRADE WITH INDIA.

The Commercial Secretary at Brussels (Mr. J. Picton Bagge) informs the Department of Overseas Trade that according to local press reports a co-operative society to be known as " The Belgian Manufacturers' Corporation " has been formed for the creation of offices in British India for the sale in British India, Burma and Celyon of the goods manufactured by the associates and for all commercial operations intender to develop the export of Belgian products to India.

A centralising office is to be opened in Brussels in order to carry out business, concentrate certain expenses, and permit of the rational solution of grouped shipments; to facilitate exports to India, and to create a service of commercial and industrial information concerning the Indian market.

The capital is unlimited, but fixed at a minimum of 675,000 francs, represented by 135 shares, fully subscribed by leading Belgian firms.

CANADIAN PRODUCTION OF ASBESTOS.

According to finally revised statistics just issued by the Mining, Metallurgical and Chemical Branch of the Dominion Bureau of Statistics at Ottawa, asbestos production in Canada during 1926 reached a grand total of 279,403 tons with a valuation of $10,099,423. In 1925, the shipments (exclusive of the by-product sand and gravel) amounted to 273,524 tons at $8,977,546. The average value received by the operators in 1926 was 36.15 per ton, as compared with 32.82 per ton in the previous year.

BOARD OF TRADE ANNOUNCEMENT.

SAFEGUARDING OF KEY INDUSTRIES.
APPOINTMENT OF REFEREE AND PANEL.

Under the provisions of Section 1, subsection (5) of the Safeguarding of Industries Act ,1921, and of Section 10, Subsection (4) of the Finance cAt, 1926, compaints as to the improper inclusion of articles in, or their exclusion from, the lists of articles chargeable with duty under Part I of the Safeguarding of Industries Act, as amended by the Finance Act, 1926, have to be referred for decision to a tribunal consisting of the Referee appointed by the Lord Chancellor and of two persons selected by the Lord Chancellor from a panel of persons of special scientific attainments appointed by the President of the Board of Trade.

The Lord Chancellor has appointed Mr. A. A. Hudson, K.C., to be the Referee, and the President of the Board of Trade has appointed the following gentlemen to be the panel of persons of special scientific attainments :—

Mr. A. Chaston Chapman, F.R.S.; Prof. F. G. Donnan, C.B.E., F.R.S.; Dr. J. H. Jeans, F.R.S.; Prof. F. A. Lindemann, F.R.S.; Prof. S. Smiles, O.B.E., F.R.S.; Prof. J. F. Thorpe, C.B.E., F.R.S.

NOTICES OF BOOKS.

Aids to Biochemistry. By E. ASHLEY COOPER, D.Sc.(Lond.). F.I.C., A.R.C.S. (Lond.)., and S. D. NICHOLAS, B.A (Oxon.) A.I.C., Lecturers in Chemistry, University of Birmingham. III + 188. Price 4s. 6d. net. London: Ballière, Tindall and Cox, 7 and 8, Henrietta Street, Covent Garden, W.C.2.

The object of this well-written book is to help students in a supplementary sense, which it is well calculated to do, being compact, and reliable. An elaborate alphabetical index and subject matter contents reference is made easy to the reader. There are several useful diagrams.

Chemistry of Familiar Things. By SAMUEL SCHRUCKER SADTLER, G.B., Member of the American Institute of Chemical Engineers, etc., etc. Fifth Edition, revised and enlarged. XIX + 836. Price 15s. London: J. B. Lippincott Company, 16, John Street, Adelphi, W.C.2.

This book has established a firm position for itself during the twelve years that it has been before the public. The present edition has been revised, enlarged, and brought up to date, so that it can lay claim to a continuance of its popularity. While the work will naturally appeal to those with some knowledge of Science, it is yet written in an easy style and deals with so many familiar things—air, water, metals, rocks, food, soil, ets., etc., that it can be both read and re-read with pleasure and advantage by any intelligent knowledge-seeking reader.

Aluminium Bronze Powder and Bronze Paints. By JUNIUS DAVID EDWARDS (Assistant Director of Research, Aluminium Company of America). Pp. 104, with 18 appropriate illustrations. New York: The Chemical Catalog Company, Inc., 419, Fourth Avenue, at 29th Street, U.S.A.

The bronze powder and bronze paint industry has assumed considerable importance and an authentic work like the present book by a practical author is a useful addition to the scientific library. The origin of bronze powders and the correct method of their manufacture so as to ensure proper brilliancy are stated briefly and clearly. So also are the examination tests and standards, composition, properties, and uses. The properties, uses, etc., of aluminium paint are shewn. The illustrations are very handsome, such as figure 16, suggesting possibilities and uses of aluminium ink on coloured cover.

OFFICIAL U.S.A. PUBLICATIONS.

GEOLOGICAL SURVEY.

The Iniskin-Chinitna Peninsula, Alaska (U.S.A. Geological Survey). Pp. 70. 50 cents.

Geology of the Upper Matanuska Valley, Alaska. Pp. 92, with maps. 80 cents.

Surface Water Supply, 1922, *Colorado River Basin*. Pp. 172. 25 cents.

Surface Water Supply, Pacific Slope Basins in Calafornia, 1922. Pp. 406. 50 cents.

...*Surface Water Supply of Hawaii*, 1922-23. Pp. 174. 25 cents.

BUREAU OF MINES.

Subsidence due to Coal Mining in Illinois. Pp. 60, with Map. 30 cents.

Quarry Problems in the Lime Industry. Pp. 98. 25 cents.

Production of Sponge Iron. Pp. 176. 55 cents.

Placer-Mining Methods and Costs in Alaska. Pp. 236. 55 cents.

Identification of Oil-Field Waters by Chemical Analysis. Pp. 22. 5 cents.

Zinc in 1925. 5 cents.

Copper in 1925. 10 cents.

Builders' Hardware. Two parts. 10 cents each.

Weights and Measures Laws in the U.S.A. and her possessions. A comprehensive work has been revised and copies can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C., U.S.A. Price $2 30 cents.

ALCHEMICAL LITERATURE.

TWO IMPORTANT INDIAN PUBLICATIONS.

It is becoming apparent that there is a revival of scientific interest in Alchemy. Two new and important contributions have appeared in India, and merit attention. The first is a bound volume by DR. BHUDEB MOOKERJI, M.A., entitled *Rasa-jala-nidhi*, or *Ocean of Indian Chemistry and Alchemy*, and is the first of a series to be edited by him. The second, by PROF. H. E. STAPLETON, THE LATE R. F. AZO AND DR. M. HIDAYAT HUSAIN, is contained in the *Memoirs of the Asiatic Society of Bengal*, vol. VIII, No. 6, and is entitled *Chemistry in Iraq and Persia and the Tenth Century* A.D.

(1) Hindu chemistry and alchemy is a subject almost unknown and our indebtedness to the Indians' early contributions to the development of Science were briefly dismissed in my *Brief Outline of the History of Science*. We are therefore especially grateful to Dr. Bhudeb Mookerji for his compilation. He points out that it is physically impossible to keep a detailed chronological record for more than 25,000 years, but he considers the Indian Puranas (ancient records) are authentic. According to the Puranas the world is eternal, creation being taken to mean periodical reconstruction after dissolution. The age of the present world since the last reconstruction is given at 1,955,885,027. This figure is based upon a tradition transmitted from generation to generation through science, philosophy, history and scriptures.

Rasavidya, or chemistry and alchemy, began to be cultivated by the ancient Aryas early in the present Kalpa or era, according to fragments of two books attributed to the great Rama Chandra. Thus chemistry flourished at least 900,000 years ago in India.

Most of Dr. Bhudeb Mookerji's book is concerned with the (somewhat grotesque) methods of purifying and preparing mercury for medicinal purposes. The actual processes are made unnecessarily complicated by the introduction of many organic and inorganic substances which can hardly be said to have a chemically purifying effect. However, details are given for the preparation of mercury for use in medicine and for transmuting itself or base metals into gold, etc. The bilingual text is accompanied by a glossary and definitions and is preceded by a valuable introduction.

(2) The volume on the chemistry in Iraq and Persia in the tenth century A.D., is a continuation of the authors' study of the alchemical knowledge acquired by the Arabs. The three documents dealt with are the *Madkhal at-Ta'limi* (Instructive, or Practical Introduction) and *Kitab al-Asrar* (Book of Secrets) by Ar-Razi and the encyclopædic *Mafatih al-Ulum* (Keys of the Sciences), by al-Khwarazmi.

All three are undoubtedly important works and the two by Ar-Razi serve to show that this prolific writer had a wide knowledge of chemistry. To him are attribnted 100 medical works, 33 treatises on natural science, 12 on alchemy, 11 on mathematics and astronomy, and more than 45 others. A short biographical sketch of him is given. The documents, one of which is produced in the original, are discussed from the chemical point of view and the authors conclude that the evidence they advance indicates that by 900 A.D. chemistry had already become an exact science.

Of both works under review is may be said that further publications will be awaited with interest.

J. G. F. D.

(1) *Rasa-jala-nidhi*, or *Ocean of Indian Chemistry and Alchemy. Vol. I.* By R. K. Mookerji, M.A. Pp. xvi + 350. 8. From the author, 41a, Grey Street, Calcutta. Price 6 rupees (India), 10 rupees (abroad).

(2) *Chemistry in Iraq and Persia in the Tenth Century* A.D. By Prof. H. E. Stapleton, M.A., the Late R. F. Azo, and Dr. M. Hidayat Husain. Pp. 100. Asiatic Society of Bengal, 1, Park Street, Calcutta. Price 5 rupees 1 anna.

Evolution Disproved. By Rev. William A. Williams. Pp. 125. Published by the author, Camden, New Jersey, U.S.A. Price one dollar.

In this work the author has concisely mar·halled all the facts against the theory of the evolution of Man from lower animals and has brought much mathematical science to his aid. He wishes to accept as valid every proved theory of science (*e.g.*, Gravitation, and Copernican theories) but he concludes that the theory of evolution is so out of harmony with the facts that it is untenable and has done untold harm to mankind.

The book is divided into three parts. Part I endeavours to disprove the evolution of the human body; Part II disputes the alleged proofs of evolution; Part III maintains that the evolution of the soul is impossible. It is assumed that the world is 18-20 million years old and has been inhabited by man for about 6,000 years, *i.e.*, as far back as records exist. This time is too short to allow for the gradual evolution of all the species iuhabiting the world to-day. The Rev. Williams gives three million as the number of these and goes on to urge that not one of them has been evolved within 6,000 years.

He emphasises the lack of evidence concerning the " missisng links " in Darwin's " chain " of man's evolution fro man ape-like ancestor and is merciless in his criticism of the value of the evidence from the Heidelberg, Java, Piltdown and Neanderthal skulls, etc. He enunciates eight impassable gulfs which, he contends, invalidate the theory of evolution; they are between living and dead matter, between vegetable and animal kingdoms, invertebrates and vertebrates, marine animals and amphibians, amphibians and reptiles, reptiles and birds, etc. Specialists in different branches of biology will not always agree with him. Thus, it is hard to define the difference between plant and animal life, they merge into each other so gradually.

Whilst the author has criticised much of the more vulnerable evidence, he has little to say about embryology or the recapitulation of the species. In my *Brief Outline of the History of Science*, mention is made (p. 120), of the gorse (Ulex) whose ordinary leaves are spiny to protect it from herbivorous animals, but the first few leaves of the seedling are similar to those of clover. This suggests a common origin with other leguminosæ. It is not an isolated case but is a typical one.

It might also be pointed out that some of the mathematical evidence is vitiated by such castrophic happenings as the glacial periods.

Whatever views on the subject are held, it can safely be asserted that the Rev. W. A. Williams' work is worthy of careful perusal.*

J. G. F. D.

* It may be obtained through *The Chemical News*, price 5/6, by post only.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

22,273.—Brucklmayr, G.—Treatment of gases for removal of hydric sulphide, etc. August 24th.

22,596.—I. G. Farbenindustrie Akt.-Ges. —Process for production of ethylene. August 27th.

Specifications Published.

276,146.—Geere, E .W.—Control or regulation of the production of carbon dioxide.

276,216.—Combustion Utilities Corporation.—Purification of tar acid-bearing oils.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His *Majesty's Stationery Office.*

TEABROL BRAND.

480,906.—All goods in class 3 which includes chemical substances prepared for use in medicine and pharmacy, but not including soap or ointment and not including any goods of a like kind to soap and ointment.—H. R. Napp, Limited, 3 & 4, Clements Inn, Kingsway, London, W.C.2. *August 31st.*

EMSALVA.

482,077.—All goods in class 3 which includes chemical substances prepared for use in medicine and pharmacy.—Eustace Hamilton Miles, 10, Ridgmount Gardens, London, W.C.1. August 31st.

INCRETONE.

482,917.—Chemical substances prepared for use in medicine and pharmacy.—G. W. Carnwick Co., 417 to 421, Canal Street, New York, State of New York, United States of America. August 31st.

BITUGLAZE.

481,185.—All goods in class 1 which includes acids, potash, salts and other chemical substances used in manufactures.—Roberts Glazebrook & Co., Ltd., Tyseley Paint and Varnish Works, James Road, Tyseley, *Birmingham. August 31st.*

GENERAL INDEX TO THE
"CHEMICAL NEWS"—VOLS. 1 TO 100.

This large volume contains a detailed Index to the first 100 volumes of the *Chemical News*, and will be found of great value to all interested in Chemical, Engineering, Electrical and General Scientific subjects. It has been compiled with great care, is handsomely bound in red cloth, and has been produced at great expenditure of *time, labour and money. Carriage paid,* Great Britain, 1/- net; Carriage paid to Foreign Countries and the Colonies, 23/- net.

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By DR. C. G. DOUGLAS, C.M.G., M.C., D.M., F.R.S., *President of the Section.*
(*Before the British Association, Leeds,* 1927.)

"In physiology our task is to study the nature of the phenomena which characterise normal life, as shown in the individual organism. At the outset it would perhaps seem presumption on our part to turn our attention to what we must admit to be the most complicated and highly-developed organism, namely, man, before we have been able to elucidate at least the main features of the life-process of more lowly forms; should we not do better to argue from the simple to the complex? Yet I suppose that man has always been curious about himself, his functions and existence, and nothing is likely in the future to lessen this curiosity. It is no matter for wonder, therefore, that the early history of physiology is bound up with the development of medicine, and that those whose daily life necessarily brought them into continual association with health and disease, and with life and death, should be among the first to turn their attention to the investigation of the nature of the living processes.

It is not, however, of the early days of physiology that I propose to speak. The progress made in the biological and physical branches of natural science has been amazingly rapid in recent years, and I want to try to reach some estimate as to the value of human physiology in the development of modern physiological thought.

In the last fifty years we have seen the wide extension of what I may term the analytical method of physiological investigation, the attempt to differentiate the various components in the complex system which we call life, and to study in detail each of these components in turn and to render clear the phenomena peculiar to each. The organism is in this method treated as a series of systems—we speak, for instance, of the nervous system, the circulatory, the respiratory and the excretory systems—which, though no doubt but parts of a whole, are yet capable of being treated within limits as independent. In pursuing this method we have a perfectly definite aim, for we are trying to establish elementary facts about the different parts of the body without some knowledge of which we feel, and feel rightly, that a general conception of the whole is impossible. No one can deny that we have acquired in this way a mass of information which is essential to the whole study of physiology, nor is there any reason to suppose that the future will witness any diminution either in number or importance of the contributions thus made to knowledge.

The bulk of this information has been attained by the deliberate and careful investigation of animals by experimental methods, and as I am going to plead the cause of human physiology, may I say at once, lest you should misconveive my purpose, that I do not believe that progress in physiology and in medical science to the lasting benefit of mankind is possible without employing such methods. But, while acknowledging the great debt which we

already owe to these investigations, and my firm conviction that their further prosecution will be fully justified in the future. I *have to face the question whether the* method has not in reality some limitations.

We are bound, I think, to admit frankly that direct observation by methods involving operative procedure on the anæsthetised animal cannot by itself give us the full answer we require. I have defined physiology as the *study of the nature of the phenomena* which characterise normal life, and normal life involves constantly varying activity of all the different organs of the body. Under the influence of an anæthetic our subject is no longer normal, and we have perforce deliberately to close our eyes to *that fundamental aspect of life—ceaselessly* varying natural activitl. We are forced to adopt methods of investigation which are essentially highly artificial; the stimuli which we employ are usually coarse, and the changes to which we subject the organs gross, compared with the delicate *alterations to which these same organs* respond in natural life. But even if we admit this, are we to condemn the method? Certainly not, in my opinion, provided always that we recognise that there is this risk of abnormality and artificiality, and honestly ask ourselves the question—what is the precise *sigificance of our results in relation* to normal life? how far do our observations really help us to understand the phenomena associated with the natural existence of the organism? We may be accumulating facts; can we translate them?

If we are to understand life we must ultimately adopt methods of investigation which do not interfere with the normality of the organism or its power of self-maintenance; and clearly, so long as we keep this aim before us, we are perfectly justified in making our observations on any animal the study of which we think will help to solve our problem. The conditions will be satisfied so long as our experimental treatment, whether that involves operative procedure or not, does not materially prejudice the delicate regulation of bodily functions which is so evident in the normal intact animal. Pavlov's classical researches on the secre*tion of the digestive juices were principally* made on dogs which, though previously subjected to operation, were yet capable of exhibiting the normal functions and activities of life, and the requisite conditions were therefore just as effectively fulfilled as in, for example, the fundamental observations made by Rubner on nutrition and energy liberation when absolutely intact animals served as subjects. And yet, n spite of such examples, the point which I want to emphasise is that in the study of normal physiology man is in many instances a far more advantageous subject for investigation than are the lower animals.

It may be urged that, so far as concerns the natural variations in activity of everyday life, we may study the lower animals just as profitably as man. But can we guarantee that any animal, even though highly trained, will provide the particular state of activity that we may require at the moment? Man at least will conform with our requirements, and will maintain at request either rest or any degree or type of activity which we may desire. What is more, he, though himself the subject of investigation, can help us to make our observations, and very often intelligent co-operation on the part of the subject may render easy experimental procedure which would otherwise be impossible. We gain, too, the advantage of learning the subjective impressions of the person on whom we are making our experiments. Everyone will admit the importance of these impressions when studying the physiology of the sense organs, but may they not be of value, too, in the investigation of other functions? Indeed they may help us not infrequently to gauge the normality or abnormality of the conditions under which we are working. The point of view of the mere spectator is, after all, an impersonal one, and if it can be amplified and perhaps corrected by reference to the feelings of the subject so much the better. The investigation of life is too difficult a task to allow us lightly to discard any method which may help us, and if we confine our attention to the lower animals we do *limit ourselves* to objective experience and renounce the possibility of assistance from subjective impressions.

Can my assertion that there is a definite advantage in doing experiments on man be justified by the information that has already been gained from investigations on *the human subject? Let me briefly* discuss the position.

We know, it is true, not a little about the respiratory exchange of animals, but we can fairly claim to know very much more about the oxygen consumption, CO_2 output and energy exchange of man. Data have been *obtained on man whilst resting*, walking, running, pedalling a bicycle, rowing,

swimming, traversing the snow on ski or the ice on skates, performing military exercises, hewing coal at the pit face or pursuing other industrial occupations, and doing mental—a fairly representative collection of man's various activities in his daily life.

Such information is not of mere academic interest; it has not been obtained solely to satisfy our idle curiosity: it is fundamental to physiology. We learn from it how greatly the oxygen requirements and the energy output vary with changes in occupation—we find that the energy output when walking at four miles an hour is five times as great as during rest, and that the trained athlete may for a number of minutes maintain an oxygen consumption not far short of twenty times the resting value—and we begin to realise quantitatively something about the latent possibilities in the respiration, circulation and other bodily functions which must be called upon to adapt themselves from moment to moment to meet such widely varying demands. Observations on the general metabolism and energy exchange in may have played, too, a conspicuous part in the development of our knowledge of the general principles of dieties and of the science of nutrition both of the individual and of the nation.

Research on the intact, or practically intact subject, naturally demands methods of investigation of very different character from those direct experimental methods which may be employed when full functional integrity is no longer preserved. The history of the development within recent years of our ideas about respiration has afforded a striking example of the application of such methods. Twenty-two years have elapsed since the publication of Haldane's and Priestley's classical paper on the regulation of the lung ventilation. Up to that time our knowledge about the breathing was surprisingly small: we accepted the fact of the apparent automaticity of the breathing, and recognised that the respiration adjusted itself suitably to changes in bodily activity, but we had no satisfactory explanation to offer; isolated facts were known, but we could not combine them into an intelligible whole. Then suddenly light was thrown on the whole situation by a series of experimental observations on human subjects in full possession of their normal faculties and with their natural powers of response to changes in their immediate environment unimpaired. The reason for the activity of the respiratory centre in the brain was shown to be due in the main to the fact that it was sensitive to the actual concentration of CO_2 in the arterial blood which reached it. A trifling rise in this concentration above the value shown during quiet breathing at once caused hyperpnœa, a trifling fall was at once followed by reduction, if not complete cessation of the breathing. As the determining factor was apparently the concentration of CO_2 in the arterial blood, a concentration set by the composition of the air in the depths of the lungs, it became evident that the activity of the respiratory centre was proportional to the mass of CO_2 produced in the body and carried to the lungs, and this in turn implied that the quantitative correlation of the ventilation of the lungs with the changes of metabolism in the body as a whole was ensured by chemical means. From this work, too, we gained our first real insight into the amazing delicacy of true chemical correlation within the organism.

Since that date innumerable contributions have been made with man as the subject of investigation. We recognise now that the respiratory centre is sensitive not to CO_2 as such but to changes in the hydrogen ion concentration of the blood, that lactic acid accumulation as well as increased CO_2 production must be taken into account when studying the hypernœa caused by muscular exertion, and that reduction in the oxygen concentration in the arterial blood and alteration in the temperature of the blood may play contributory parts. Yet in spite of this, the fundamental conception of accurate chemical or physico-chemical co-ordination of function remains unimpaired; so long as the respiratory centre is sensitive to chemical or physical changes which result from alterations in activity of the different organs, the quantity of air breathed must be co-ordinated with the varying metabolism of the body.

And when once we have ascertained the quantitative alterations in the respiratory exchange which correspond with our varying activity during the course of the day, and have grasped the fact that the breathing is automatically adjusted in correspondence with the tissue metabolism, because the cells of the tissues are so intimately linked with the respiratory centre in the brain by the blood stream that the degree of activity of the respiratory centre is actually determined by the events in those organs whose metabolism happens to vary, we are led on logically to a further inquiry. For so delicate an adjustment of the

breathing in conformity with changes in the activity of the tissues would be valueless without an equally delicate co-ordination of the circulation, since on this depends the transport of gases between the tissues and the lungs; nor would this suffice unless the blood were of such a nature as to afford a suitable medium for the carriage of oxygen and CO_2.

So far as our knowledge of the properties of the blood itself is concerned we can point to a great deal of progress. Naturally enough, the blood of many different animals has been investigated, but it has been found that the dissociation or absorption curves, which express the relationship between the amount of gas held in dissociable combination in the blood and the concentration of that gas to which the blood is exposed, differ in different species, and indeed in different individuals of the same species, and this fact makes it imperative that in physiological work the properties of the blood of the individual under consideration at the time should be investigated. Correct inferences as regards the properties of human blood from which we may deduce the exact part played by the blood in gas transport cannot therefore be drawn from studies of the blood of lower animals, and in consequence we find that more and more attention is being directed to the experimental investigation of the blood of man under widely carying conditions, both in health and in disease.

I suppose that as much attention has been directed by physiologists to the circulatory system as to any other branch of physiology, and yet when we begin to question ourselves about the true functional regulation of the circulation our information still seems to be amazingly hazy and indefinite. Direct observations on the anæsthetised animal with the assistance of recording instruments have established a number of perfectly definite facts. We have some notion of the mechanics of the circulatory system; we have ascertained the general course and distribution of the vaso-motor nerves; we have found that not only the arteries but even the capillaries are capable of active contraction and dilation; we have identified the powerful effect that may be exerted on the larger blood vessels and capillaries by the products of the ductless glands and by substances produced in the metabolism of the tissues. We have gone further than this; we have by means of artificial methods of stimulation identified

that the heart when isolated from the body can deal with an increase in the rate at which venous blood is supplied to it by altering its amplitude of beat without any variation in rate, though if its nervous connections are intact an acceleration of the venous return causes a reflex increase in the pulse rate, the antithesis of the reflex retardation caused by an undue rise of arterial blood pressure.

But what does all this seemingly exact knowledge amount to? Are we not really only showing up the potentialities in the circulatory system? It may be argued that we shall gradually build up the whole as our knowledge of the component parts becomes more complete, but I retort—can you build up the whole without a preliminary notion of its characteristic qualities? Surely before we attempt an explanation we must know what it is that we are trying to explain. The circulation has to supply oxygen and foodstuffs to the tissues, it has to remove CO_2 and other waste products from them. Well, what are the claims made on the circulation in everyday life? We can answer that question in the case of man from our knowledge of the changes in his metabolism under different circumstances. Here then are the demands; how does the circulation actually accomplish its task; what are the facts of the case?

(To be Continued Next Week.)

RUSSIAN CHEMICAL EXPANSION.

Important developments are now taking place in the Russian chemical industry, and considerable extensions of plant have already been arranged.

More than £3,000,000 is to be spent during the present economic year on these developments and it is anticipated that as a result the manufacture of heavy chemicals will be increased very considrably.

The money is to be divided as capital expenditure between the three largest Russian chemical concerns, the Northern Chemical Trust, the Chemica-Coal Trust, and the Moscow Heavy Chemical Trust. These three concerns will not only increase their present manufacture of chemicals, but will instal plant for the production of various chemicals which have had to be imported in the past.

Last year the value of heavy chemicals manufactured in Russia amounted to just over £7,000,000. It is anticipated that this year the value will be increased to at least £10,000,000, possibly more, and that much

THE ACTION OF STANNOUS CHLORIDE ON SILVER MIRROR FORMATION.

By Dr. O. Macchia.

It is well known[1] that the reduction of $Ag_2(NH_3)_2(OH)$, the hydrate of silver diamine (ammoniacal silver hydrate), and the reduction of nitrate of silver diamine (ammoniacal silver nitrate), $Ag(NH_3)_2(NO_3)$, into metallic silver (looking-glass mirrors), and the adherence of the latter to a glass plate[2] is very much facilitated by previous immersion of the glass in a *solution containing stannous chloride*, $SnCl_2$, even when in the smallest quantities (down to a dilution of 1 in 2,000. Namias, in his valuable work[3], admits the formation of a tin silicate (produced by the reaction of the tin chloride and the silicates of which the glass is composed), which, as it deposits tenaciously on the surface of the object, facilitates the reduction and the adherence of the silver.

I started this stndy in order to see if there should be any possibility to prove the hypothesis of Namias, but when I had finished the whole experimental part which I had intended to go through, I came to the following conclusions :

(*a*) That the hypothesis of Namias does not correspond to the facts;

(*b*) That admitting the hypothesis found by me (and corroborated by experimental proof) to be corresponding to the facts, the phenomena seen during the silvering are easily explained.

Apart from the main object of the research it was my intention to carry out investigations to solve the following problems.

1. At first to see if the tin silicate really facilitates the reduction of the silver and the adherence, since these two effects would disappear if the object to be silvered did not contain silicates.

2. By using a solution of sodium stannite, the aforesaid facts (*i.e.*, increasing reduction and adherence) should also cease as the silicate of tin should be dissolved in the slight excess of free sodium hydroxide existing in the alkaline tin solution when freshly prepared.

The solution for silvering used in all experiments was prepared according to the method of Miethe as Namias has indicated, i.e. :

The following solutions are first prepared :

Solution A :	Silver Nitrate	50 gr.
	Water	900 c.c.
B :	pure hydrate of potash	20 gr.
	Water................	900 c.c.

To 750 c.c. solution A, ammonia is added drop by drop until the brown precipitate of Ag_2O is redissolved. Then the 900 c.c. of Solution B is added with agitation. Afterwards there is to be added more NH_4OH until the precipitate of Ag_2O is re-dissolved. Drop by drop, we add what remains of solution A until the solution has assumed a slight colouring of yellow-brown, *i.e.*, a little Ag_2O remains suspended. The reducing solution used was the one indicated from Namias. This solution thus prepared has to be boiled for about ten minutes. It is composed of

Sugar	25 gr.
Tartaric acid	3 ,,
Water	200 ,,

after having cooled it we add 50 c.c. of ethyl alcohol 95 per cent., to maintain the solution, and then we add distilled water until the volume has reached 250 c.c. The boiling is necessary in order to transform quicker the saccharate $C_{12}H_{22}O_{11}$ into *d*-glucose $CH_2OH(CHOH)_4CHO$ and in *d*-frutose $CH_2OH(CHOH)_3COCH_2OH$.

For every silvering I took 20 c.c. of the silvering solution, together with three c.c. of the reducing solution and 3 c.c. of water.

For the solution of tin chloride (in all my experiments I used solutions of about 1 part of $SnCl_2$ in 1,500 of water), I prepared beginning with the purest and previously tested tin, pure tin chloride (absolutely free from the stannic compound) and I kept it (to avoid that during the different trials it might be altered) suspended in absolute alcohol. The solution of about 1 in 1,500 I prepared just at the moment I had to use it. After having well agitated the vessel to stir up the suspended tin chloride. I took a known quantity of alcohol containing suspended $SnCl_2$ and added afterwards the calculated quantity of distilled water to get the 1 in 1,500 solution.

To prove experimentally the first question I had intended to answer (*i.e.*, if really the tin silicate was the cause that silver was reduced and adhered to an object contain-
20 minutes. I next prepared the solution prevent silvering with things not containing

silicates. Using the same procedure, I chose for silvering three objects which seemed to me the most adapted for the purpose to solve the question I intended to answer. They were celluloid, wood and galatite.

Of course, two trials were necessary for every silvering to be accurately observed; the first one without previous immersion of the object in the solution of tin chloride and the second one with immersion of the object in the solution of tin salt for about ing silicates) these two suppositions would (1 in 1,500) in a small basin, of the same substance which I intended to silver, in order to avoid the silicates having any influence on the solution of tin chloride. Also the silvering proceeded in a basin of the same substance (as wood, for wooden plates, and celluloid for celluloid plates, etc.).

Silvering Celluloid.—First operation.—After having cleaned carefully the surface of the plate with alcohol and washing I immersed the plate for 20 seconds in the solution of tin chloride. After washing I immersed the plate in the silvering bath, observing a slight deposit of silver (mirror) after 18 to 20 seconds. The silver mirror formed by the silver deposited is very adherent.

Second operation.—After having cleaned in the above way the surface of the plate, I immersed the plate directly in the usual silvering bath. I observed a slight deposit of silver after one minute 45 seconds to one minute 55 seconds. The silver deposited, although it had a sufficient consistency, was much less adherent than that obtained by the first operation.

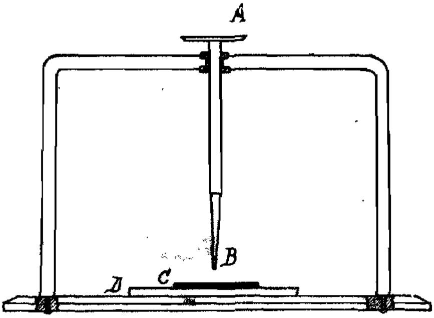
Silvering Wood.—First Operation.—The wood chosen was taken from a fir tree and was well preserved. After having smoothed the surface to be silvered (haviug polished it with glass paper up to the number 00000) I polished it by alcohol and washed it again with abundant water. I then immersed the plate in the usual solution of $SnCl_2$ for 20 seconds. After washing with water I immersed it in the usual silvering bath. I was thus able to observe a slight silver deposit after 30 to 35 seconds. The silver deposited is sufficiently adherent.

Second operation.—I prepared the surface of the wood to be silvered iu the usual manuer and immersed it directly into the silvering bath. I observed a slight deposit of silver after two minutes and fifty seconds to three minutes and ten seconds. The silver was scarcely adherent.

Silvering of Galatite.—First Operation.—Having cleaned very carefully with alcohol the surface of the plate, I immersed the plate in the solution of $SnCl_2$; I washed it again and then silvered. I observed here a slight deposit of silver after 25 to 30 seconds. The cover of deposited silver is very adherent.

Second Operation.—Without the previous immersion in the solution of $SnCl_2$ I observed a slight deposit of silver after one minute and thirty to thirty-five seconds. The cover of deposited silver was little adherent.

The adherence has been proved in all the operations when the plate was perfectly dry by means of a kind of sclerometer here illustrated.



On the small plate ,A, I put the weights to get the needed pressure. The point B of 4 mm. had been carefully covered with deerskin. The plate, C, has been well fixed with 8 hooks on the moving small plate, D. To be able to observe the rupture of the silver cover, I took away by means of a little piece of the deer skin, the silver coats from one part of the plate. Between the surface of the plate C and the small plate D, I put white paper. This for transparent objects as glass or celluloid, only served to delay action on the back where the rupture of the silver cover took place, rupture caused by the point B of the sclerometer. For the wood and the galatite (opaque objects), all this was useless. The dimensions of the plates were about 70 by 80 mm. The thickness was different, varying according to the substance, from 2 to 4 mm.

TABLE I.

	Plate first immersed in the solution of $SnCl_2$ at 1/1500 for 20 seconds.		Plate not immersed in the solution of $SnCl_2$.	
	Beginning of silvering after seconds	*The silver cover torn under the pressure of Kg.*	*Beginning of silvering after seconds*	*The silver cover torn under the pressure of Kg.*
Glass	12—14	18—19	100—105	.015—.020
Celluloid ...	18—20	14—15	105—115	.050—.055
Wood	30—35	6—7	170—190	.020—.025
Galatite ...	25—30	12—13	90—110	.100—.150

The temperature was 20° C throughout.

Treating now the second question we shall conclude thus : As the characteristic qualities of the composed of tin chloride adherent to the surface to silver show themselves, using also extremely diluted solutions, even 1 in 2,000), it is logical to conclude that the compound of $SnCl_2$ remains adherent at the surface in only very small quantities. It follows also that, using a solution of sodium stannite, the phenomenon should not appear, as always admitting the possibility of formation of tin silicate, which by and by deposits on the surface of the plate of glass and dissolves slowly. It is true, experimentally, that if, after having immersed the plate in the solution of $SnCl_2$, we immerse the same plate in a solution of 10 to 12 per cent. sodium hydrate (or potash) we do not again meet these phenomena caused by the presence of tin salt, during the silvering. This could, in a certain manner, prove the hypothesis of the formation on tin silicate. This is however due to the slight corroding done on the glass plate by the solution of NaOH.

Using the solution of sodium stannite, Na_2SnO_2 called also alkaline solution of tin chloride) we get also a slight corroding produced by the excess of NaOH existing in the alkaline solution, but in this case the continuous contact that the surface is subjected to, this remains always adherent in a small quantity. The adherence of the thin cover of sodium stannite is remarkable and in such a way to permit the plate being washed by water without the cover of Na_2SnO_2 disappearing. In Table II. the quickness of the formation and adherence of the plates previously immersed for 20 seconds in a solution of 5 per cent. of Na_2SnO_2 is indicated. I prepared the sodium stannite, starting from a known quantity of tin chloride $SnCl_2$ pure, and adding the reckoned out quantity of NaOH. Each time I prepared the Na_2SnO_2 and added the calculated quantity of water (to get a solution of 5 per cent.) Thus the quantity of stannite that oxydated (by the oxygen of the air) into metastannate, Na_2SnO_3, was a very small one. The silvering of the different plates has been executed using the same quantities of silvering and reducing solution used in the preceding silverings.

TABLE II.

	Plate first immersed in the solution of 5 per cent. Na_2SnO_2 for 20 seconds.	
	Beginning of silvering after seconds	*Silver cover is torn under the pressure of Kgr.*
Glass	20—24	10—11
Celluloid ...	28—32	15—16
Wood	40—50	.500—.550
Galatite ...	29—35	14—15

Formation of Stannic Compound.—From my experiments I explain the formation of this compound on the surface to be silvered in the following manner : The solutions of

$SnCl_2$ used are always very much diluted, and using concentrated solutions the silvering does not become perfect owing to phenomena still unexplained.

Tin chloride, as the salt generated from a strong acid HCl and a weak base $Sn(OH)_2$, is undergoing in aqueous solution the hydrolysis which is increased with the growing dilution. The hydrolysis as is known is proceeding in two stages; the first part is formation of basic stannous chloride $Sn(OH)Cl$, and this last one from its part reacting with another molecule of water is transformed into stannous hydroxide $Sn(OH)_2$. In our case, as the solution is very much diluted, we can suppose that hydrolysis is complete *i.e.*, the equilibrium

$$SnCl_2 \rightleftarrows Sn(OH)Cl \rightleftarrows Sn(OH)_2$$

is completely directed to the right. By the dilution most of the $Sn(OH)_2$ remains dissolved in the colloidal state as hydrosol. With time, however, the hydrosol of $Sn(OH)_2$ coming into contact with the surface of the object immersed in the solution assumes the form of hydrogel fixing energetically on the surface[4]. Thus it is enerplained why the solution of $SnCl_2$ does not keep for long. Indeed (supposing of course as always that the solution of $SnCl_2$ comes into contact with a surface perfectly clean when the hydrosol of $Sn(OH)_2$ conmes into contact with the surface of the object, it becomes transformed into the hydrogel of $Sn(OH)_2$, *i.e.*, the equilibrium :

$$\text{hydrosol } Sn(OH)_2 \rightleftarrows \text{hydrogel } Sn(OH)_2$$

goes to the right.

This transformation proceeds with great rapidity. Indeed I foud that in order to observe the properties of the $Sn(OH)_2$ deposited on the surface of a plate to be silvered, it is quite sufficient that this remains in contact with the solution for about 10 seconds. A first cause that gives the short durability to the solution of $SnCl_2$ is the continuous going towards the right in the above equilibrium, therefore after a certain time all the hydrosol of $Sn(OH)_2$ is transformed into hydrogel. The more a small quantity of $SnCl_2$ reacts with the oxygen of the air, the more it is transformed into stannic chloride $SnCl_4$ and into basic tin chloride $Sn(OH)Cl$, *i.e.*, $6\ SnCl_2 + 2H_2O \longrightarrow 2SnCl_4 + 4Sn(OH)Cl$. The latter, on the other hand, partly hydrolysing is transformed into $Sn(OH)_2$, and the gel, as we have seen. Admitting now the continuous going to the right of the equilibrium :

$$\text{hydrocol } Sn(OH)_2 \rightleftarrows \text{hydrogen } Sn(OH)_2$$

we can explain how the immersion of the object to be silvered in the solution of $SnCl_2$ cannot keep except for a short time. Indeed, the excess of hydrogel of $Sn(OH)_2$ deposited on the surface of the object to be silvered, produces a too rapid reduction, and the mirror appears to assume a slightly yellow colour. This is produced by tracks of Ag_2O (not more reduced by the bath of metallic silver) and by silver not precipitated under the reduced form of finely subdivided silver and black. Similarly, using a too concentrated solution we do not get a silvering really perfect, as on the surface of the object to be silvered an irregular deposit of hydrogel of $Sn(OH)_2$ is formed.

Concluding, the more a silvering shall be perfect, the lighter the cover is, and the more regular the $Sn(OH)_2$ precipitated. To obtain this we need to use a very dilute solution of $SnCl_2$ and it has to be immersed for only a short time.

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[1] Namias, *La fabbricazione degli specchi*—Hoepli (Milan).

[2] The best way to polish the surface of a plate to be silvered is to immerse it in a chromic acid mixture (bichromate potash and concentrated sulphuric acid) and wash it afterwards with water.

[3] Namias, as above.

[4] The adherence is a very strong one; so strong that we can rub the surface vigorously without the deposit of $Sn(OH)_2$ becoming torn.

GENERAL NOTES.

THE CHEMICAL, METALLUGICAL, AND MINING SOCIETY OF SOUTH AFRICA.

The 31st annual Report for the year ended June 25, 1927, has been issued. The number of members of all grades at the end of the financial year was 576. A number of useful papers were discussed at the meetings during the year under review, some of which were dealt with in the *Chemical News*.

INTERNATIONAL CONFERENCE ON IMPORT & EXPORT RESTRICTIONS.

An International Conference of representatives of the Governments of Members and non-Members of the League of Nations has been summoned to meet at Geneva on October 17 with a view to framing an international agreement for the abolition of import and export prohibitions and restrictions.

His Majesty's Government will be represented at the Conference by Sir Sydney Chapman, K.C.B., C.B.E., Economic Adviser to His Majesty's Government, assisted by Mr. H. V. Reade, C.B., an Assistant Secretary to the Commissioners of Customs and Excise ,as deputy delegate and Customs adviser, and by Mr. Gilbert C. Vyle, President of the Association of British Chambers of Commerce, and Colonel the Hon. F. Vernon Willey, ex-President of the Federation of British Industries, as deputy delegate' and commercial advisers.

GERMAN ELECTRIC POWER STATIONS.

The British Commercial Secretary at Berlin has forwarded the following brief summary of some of the published results of the industrial census for 1925 in regard to electric power stations in Germany :—

The census included 7,492 generating plants. Of these 5,751 were small stations with a capacity of up to 500 kilowatt hours; 1,124 plants had a capacity of from 500 to 5,000 kilowatt hours, and can, therefore, be called medium-sized; and only 617 plants existed producing more than 5,000 kilowatt hours, of which 434 plants had a capacity of more than 10,000 kilowatt hours.

The small plants supplied 4.7 per cent., the medium-sized plants 12.7 per cent., and the large ones 82.6 per cent. of the total electric current. It will thus be seen that, although the small and medium-sized are large in number, the highest percentage of electric current is produced by the few large plants.

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX CONFERENCE.

It is expected that some 200 organisations will be represented at the Fourth Conference of the Association of Special Libraries and Information Bureaux, which meets at Trinity College, Cambridge, during the week-end, September 23-26. Following a reception by Sir J. J. Thomson, O.M., Master of Trinity, Sir Geoffrey Butler, K.B.E., Senior M.P. for Cambridge University, will deliver the Presidential address, while among the many well-known experts giving papers are Sir Henry Lyons, Director of the Science Museum, Mr. A .E. Overton, of the Board of Trade, and Sir Richard Gregory, Editor of *Nature*.

SCARCITY OF PAPER IN THE FUTURE.

The subject of paper and the possibilities of utilising bamboo for its manufacture, was dealt with by Mr. William Railt, the cellulose expert to the Government of India.

He pointed out the practicability of using bamboo to meet the situation and it would cost several pounds per ton less than wood.

The world's consumption for paper and the cellulose industries was now in the neighbourhood of 15,000,000 tons a year, nearly the whole of this being from coniferous wood. The fact that this figure represented nearly 40,000,000 tons of raw wood indicated something of the strain put upon our resources by these industries. The normal expansion of paper consumption was about 25 per cent. in ten years; consequently the figure just quoted would be about 50,000,000 in 1937, and over 60,000,000 in 1947. A contributory cause of this expansion was the wonderful development during the past twenty years in uses for cellulose other than paper. For the moment the position was merely one of scarcity and higher cost, which might be represented by £7 as the cost of the wood required to produce a ton of pulp, as against £2 10s. forty years ago.

RICH GOLD DEPOSITS FOUND IN NOVA SCOTIA.

Following closely on the announcement that a rich gold deposit had been discovered in Inverness, N.S., comes another announcement backed up by a report made on ore submitted to the Nova Scotia Technical College, that a rich gold deposit has been discovered at Renfrew, Hants County. The lead from which the samples were taken is said to be from eight inches to three feet wide, and is in a district which is easily accessible.

"BRITISH-RUSSIAN GAZETTE AND TRADE OUTLOOK."

The object of this publication is apparently to foster trade between Great Britain and Russia. It is printed partly in English and partly in Russian. The September issue

dealing with harvest prospects ,says there has been an increase of 4 per cent. of the acreage under wheat and of 15 per cent. of the acreage under flax, cotton, sugar beet, grass seeds, etc. The acreage under rye and barley has decreased.

According to figures provided by the People's Commissariat for Trade for the grain campaign from 1 July, 1926, to 1 July, 1927, 11.4 million tons of grain were acquired, thus exceeding the quantity for the same period of 1925-1926 by 1.6 million tons.

The foreign currency plan for grain exports was fulfilled, it is stated, to the extent of 98.2 per cent., while in quantity the exports were somewhat behind the estimate. A very characteristic feature of the past grain campaign has been the considerable consumption of grain inside the U.S.S.R.

The plan estimated home consumption at 7,000,000 tons, whereas actually 7.7 million tons were consumed. This fact was partly due to an increase in the supplies sent to the extreme borders of the Union, particularly to Central Asia.

ELEVENTH CHEMICAL EXPOSITION (NEW YORK).

American Ceramic Society.

This meeting will take place on Thursday. September 29, at 2 p.m. in the conference room at the Exposition.

The program of this Society is in preparation and will be announced later. It is intended to collaborate with the Students' Program in some respects and be of value to the students as well as members of the Society. The Society will have an exhibit and headquarters in the Exposition.

Annual Banquet of the Chemical Industries.

The Fifth Chemical Industries Banquet will be held during the Exposition on Wednesday evening, September 28, under the auspices of the Salesmen's Association of the American Chemical Industry, sponsored by American Ceramic Society, American Chemical Society, New Jersey Section; American Electrochemical Society, New York Section; Chemical Warfare Association; Chemists' Club; Pressed Gas Manufacturers' Association; Chlorine Institute; American Institute of Chemical Engineers; American Leather Chemists' Association; Societe de Chemie Ind.; Society of Chemical Industry; American Society of Testing Materials; American Association of Textile Chemists and Colorists; Synthetic Organic Chemical Manufacturers' Association, Technical Association of the Pulp and Paper Industry, at the Hotel Roosevelt. The Committee consists of Ralph E. Dorland, chairman, Dow Chemical Co.; A. L. Benkert, National Chemical and Color Works; Williams Haynes, Drug and Chemical Markets; William Mueller, Commercial Solvents Corporation; Ira P. MacNair, MacNair-Dorland Co.; Charles F. Roth, Exposition of Chemical Industries; F. P. Summers, National Chemical and Colour Works.

The toastmaster at the banquet will be John E. Teeple, and there will be many distinguished speakers.

NORTHAMPTON POLYTECHNIC INSTITUTE.

St. John Street, London, E.C.1.

We have received a copy of the Prospectus of classes in Applied Chemistry for the Session 1927-1928, which lasts from September 26 to May 19, 1928, subject to the Christmas and Easter vacations. Affiliated with the Polytechnic are several evening Institutes in which students are prepared for entry into the Polytechnic classes. There are available in connection with the Polytechnic, various certificates, prizes, scholarships, etc. In connection with the Chemistry Department, courses are provided in chemistry, electro-chemistry, fuels and metallurgy. Part II. is suitable for the examination of the London University, while the Intermediate course of the London University is continued in Class III. There are two classes in Organic Chemistry. The Courses are all well arranged, and laboratory work is available for those students desiring same. The Institute is centrally situated, and can be reached by several services of 'buses and trams.

BRITISH FILMS IN BRAZIL.

In the course of a recent Report regarding the possibility of extending the sale of British films in Brazil, the British Commercial Secretary at Rio de Janeiro expresses the opinion that in order to stimulate interest in British films among the Brazilian public only the best examples should be exhibited, at any rate, at first, in competition with American and German films, which have obtained a firm footing.

PLAYING CARDS MONOPOLY IN TURKEY.

The British Commercial Secretary at Constantinople reports that a Law recently passed the Grand National Assembly creating a monopoly in Turkey of the manufacture, importation and sale of playing cards with the exception of those for children's card games. A tax of 100 piastres per pack will be levied on all playing cards, 75 per cent. of the resultant revenue being ceded to the Red Crescent Administration.

OVERSEAS TRADE IN AUGUST.

Exports of British produce and manufactures in August, 1927, amounted in value to £59,410,000, an increase of £3,289,000 over the exports in July; they were only exceeded in March (£62,114,000) and in May (£63,276,000). In August, 1925, however, they amounted to £61,038,000, but if the fall in values between 1925 and 1927 continued at the same rate (nearly 13 per cent.) in August as it did in each of the first two quarters of the year, British exports in August, 1927, were nearly 12 per cent. greater in volume than in August, 1925.

WHOLESALE PRICES IN AUGUST.

As measured at the Board of Trade, wholesale prices were on the average slightly lower in August than in July, the index numbers for the two months being 84.8 and 84.9 respectively (1924 = 100). Foodstuffs were cheaper by 1.5 per cent., while, owing principally to rises in the prices of cotton, industrial materials were dearer by 0.7 per cent. The averages for the three food groups show a rise of 0.9 per cent. in cereals, a rise of 0.1 per cent. in meat and fish, and a fall of 5.2. per cent. in other foods. The August average for cotton materials shows an advance of 4.9 per cent. over het figure for July and of nearly 20 per cent. when compared with the figure for April.

PROTECTION OF ALUMINIUM AND ITS ALLOYS AGAINST CORROSION.

By H. SUTTON, M.Sc., Member, AND A. J. SIDERY, Assoc.Met. (Sheff.), Member.

(*Before the Institute of Metals.*)

Some experiments are described in which samples of aluminium and aluminium alloys were treated by various protective processes including anodic oxidation, zinc-, cadmium-, and nickel-plating. Certain practical features of the methods investigated, and, also, the results of corrosion tests extending over periods of 1 to 2 years, are discussed. The resistance of aluminium, Duralumin, and of certain other aluminium alloys to corrosion by sea-water is considerably increased by anodic oxidation and the subsequent application of a grease, such as lanoline.

Electro-deposited coatings of zinc, 0.0005 in. thick, afforded better protection to aluminium than did coatings of cadmium of similar thickness ,but the two types of deposit appeared to give an approximately equal degree of protection when applied to alloys of aluminium. Unsatisfactory results were obtained from nickel deosits of normal thickness. Comparison is made between anodic oxidation and zinc- or cadmium-plating as methods of protecting aluminium or aluminium alloy parts of aircraft.

LOW TEMPERATURE MAGNETIC SUSCEPTIBILITY DATA OF GADOLINIUM SULFATE.

By W. F. GIAUQUE.

(From the *Journal of Chemical Education*.)

The low-temperature magnetic susceptibility data of gadolinium sulfate, $Gd_2(SO_4)_3.8H_2O$, have been shown to agree quantitatively with an equation, using natural constants and based on orientation without restraint within the solid.

The theoretical entropy changes accompanying the application of a magnetic field are considered.

It is suggested that the magnetic formulas proposed be used in connection with Woltjer and Onnes' suggestion of paramagnetic thermometry. It is also suggested that they be used in connection with the magnetic mixture method of low temperature caorimetry as previously suggested by this author.

Assuming that the entropy of a perfect crystalline substance is zero at the absolute zero of temperature, it is shown that it is not always feasible to obtain an absolute value of entropy from heat-capacity data alone in the case of substances with a positive susceptibility.

It is shown how to correct for the above deficiency when the number of units of unbalanced mechanical moment is known from magnetic data on the form of the substance existing at temperatures low enough to permit sufficiently accurate extrapolation of the heat-capacity curve resulting from ordinary thermal effects.

ON THE SILK DEGUMMING. II. THE EFFECT OF FORMALINE UPON THE SILK DEGUMMING IN ALKALINE MEDIUM.

By Takeo Takahashi.

Generally the protein reacts easily with formaline and forms the methylen-compound having a character very different from the original protein. In the silk degumming the formaline reacts with sericine in the raw silk and produces the interesting phenomena in the solvation.

The author investigated on the variation of the degummed amount and consumed alkali amount, when the formaline was added into the bath or the silk fibre was previously treated with the solution of certain percent of formaline. The effect of formaline is summarised in two ways :— (1) diminishing of the degummed amount in the bath of the equal alkalinity; (2) increasing of the reacted alkali amount in spite of the above.

These two phenomena may be explained by (1) diminishing in the dispersibility of the sericine and (2) increasing of the reactivity of the sericine with the alkali.

(1) is derived from the rigidity of the condensed product (methylen-compound) between the sericine and formaline, and (2) is deduced to the idea which the sericine has the increased acidity (or reactivity of the carboxy-group) by neutralising the amido-group with the formaline.

THE PHOTOCHEMICAL DECOMPOSITION OF ZINC SULPHIDE.

By H. B. Weiser and A. D. Garrison.

(Abstracted from *Journal of Physical Chemistry*, 1927, xxxi, 1287.)

That lithopone, a mixture of ZnS and $BaSO_4$, darkens in sunlight was observed by Phipson (*Chem. News*, 1881, xliv, 73) and Cawley (*ibid.*, 167), showed that this was due the separation of finely divided zinc formed by photochemical action. Blendes are usually unaffected, although wurtzite undergoes this change (*Chem. News*, 1891, lxiii, 88).

It is now found that zinc sulphide does not undergo this decomposition with quartz ultra-violet light in absence of water. The water does not serve as a catalyst, as in the case of the thermal decomposition of ammonium chloride; it does not act as a component for the photosynthesis of formaldehyde which would reduce the sulphide; and it does not function by being adsorbed on the sulphur atoms of so-called "centre atoms." The role of the water is that of an ionising solvent for zinc and adsorbed zinc salts yielding zinc ions which are adsorbed on the sulphide lattice rendering it sensitive to light.

Soluble zinc salts greatly increase the photochemical sensitivity of zinc sulphide. Thus unignited zinc blende can be prepared so that it will blacken on exposure to quartz ultra-violet light in the presence of zinc chloride.

Salts containing ions which are more readily adsorbed than the cations reduce or prevent the darkening.

LIEBIG'S EXTRACT OF MEAT COMPANY LIMITED.

A half-year's dividend, *viz.*, two shillings and sixpence per share (being at the rate of five per cent. per annum) less income tax at 4s. in the £, will become payable on and after 1 October, 1927, to the proprietors of the preference shares who are registered on the Company's books on the 15 September, 1927. In respect of Coupon No. 54 of the preference shares "to bearer," such dividend, less income tax at 4s. in the £ will be payable on and after 1 October, 1927, at the Company's bankers, Messrs. Glyn, Mills & Co., 67 ,Lombard Street, London, E.C.3.

SYNTHESIS OF RED DISPERSOIDAL SOLUTIONS OF GOLD BY MEANS OF AQUEOUS EXTRACTS FROM FRESH LEAVES OF PLANTS.

By Eiichi Iwase.

(Dispersoidological Dept. of the Imperial Research Institute, Osaka, Japan.)

(*Under the direction of Prof. P. P. von Weimarn.*)

Introduction.

Aqueous extracts from shavings of wood of twelve different kinds, as well as from Japanese tea, have already been used with success by Prof. P. P. von Weimarn for producing red dispersoidal solutions of gold. Recently, A. M. Janek by applying aqueous extracts from tobacco obtained red dispersoidal gold solutions.

Being convinced a priori that also *fresh* leaves would prove successful, Prof. P. P. von Weimarn suggested the author to test experimentally the synthesis of red dispersoidal gold solutions by means of aqueous extracts from fresh leaves of the following trees : cherry, pine, maple, bamboo, and camellia.

METHOD EMPLOYED.

10 gr. freshly collected leaves, washed thoroughly, and cut to pieces, were immersed in 100 c.c. boiling distilled water, and were allowed to boil for 10 minutes. The extract was then filtered from leaves through filter No. 602 e.h. Schleicher and Schuell, and was used immediately after filtration.

The object of my investigation being the obtaining of red solutions with the highest degree of dispersity possible, I followed, in carrying out the experiments, the rules established by Prof. P. P. von Weimarn, and described in his papers, "Studien über dispersoide Synthese des Goldes."

All my experiments, therefore, were carried out as follows : To 500 c.c. of vigorously boiling common distilled water contained in a one litre beaker of ordinary glass, were added, as rapidly as possible (by dumping) successively, 10 c.c. 0.1 per cent. gold-salt solution (1 gr. $AuCl_4.4H_2O$ in 1 litre of common distilled water), and 10 c.c. aqueous extract from leaves of the selected plant. The mixture was allowed to continue boiling until, through evaporation, it became reduced to half the original volume (*i.e.*, approximately, to 200 c.c.). The results of the experiments are perfectly reproducible on condition that all the manipulations in experimenting are exactly the same. Time intervals necessary to produce the appearance of colour, or its change, coincide in the experiments repeated.

Experiments with Aqueous Extracts from Leaves of a Cherry Tree.—The extraction was made from very young leaves of a Japanese cherry-tree; the extract obtained being yellow. The following table illustrates the course of changes in colour of the reacting mixture :

Time indications by the Clock :	Colour of the reacting mixture :
10 hrs. 49 min. (*The moment of pouring the gold-salt solution, and the extract, into the vigorously boiling water*).	Almost colourless.
10 hrs. 49 min. 3 sec.	Pink.
10 hrs. 53 min.	Red (between 29 and 33, according to the standard given by Wilhelm Ostwald.)
11 hrs. 13 min. (The solution has evaporated to half of its former volume).	Red of stronger intensity, with a violet tinge (between 33 and 38.)

The solution was kept in a hermetically stoppered vessel, and, after the lapse of two weeks, the red colour (between 33 and 38) of the solution had suffered no appreciable change; at the bottom of the vessel only traces of a precipitate were perceptible, under the form of several small flakes.

The author carried out experiments with extract of pine needles, leaves of maple, bamboo leaves, and leaves of camellia, with satisfactory results.

CONCLUSION.

The results of the experiments mentioned above, permit one to draw the conclusion that aqueous extracts from *fresh* leaves of plants common to our gardens (e.g. cherry, pine, maple ,bamboo, camellia) may serve as reagents for producing red dispersoidal solutions of gold. *Although the red colouring of the solutions just described do not acquire in beauty*, the brilliant red colour (between 25 and 21) of certain dispersoidal gold solutions prepared by the tartrates-method of Prof. P. P. von Weimarn, the colour of the dispersoidal gold solution obtained by means of extract from camellia leaves represents nevertheless a sample of a pure ruby red.

NOTICES OF BOOKS.

Elementary Physical Chemistry (Adapted from a Treatise on Physical Chemistry). By HUGH S. TAYLOR, D.Sc. (Liverpool), Professor of Physical Chemistry, Princeton University. Pp. X + 532. Price 16s. net. London : Macmillan & Co., Ltd., St. Martin's Lane, London.

Some few years ago a two-volume treatise of Physical Chemistry was brought out under the editorship of the present author. The volume now before us has for its object the presentation in a more compact form of the essential material of the aforementioned two-volume treatise. We think the author has successfully achieved the sought-for result. He assumes with perfect justification that a good knowledge of mathematics on the part of students of Physical Chemistry is not only desirable but practically essential, if satisfactory results are to be shewn in a reasonable time. He points out that this fact is generally recognised in the United States. The book consists of fifteen chapters, starting with the atoms, and the early pioneers of chemistry,

winding up with Colloid Chemistry (chapter XV). There are many illustrations and a good index, while the printing and binding of the volume are creditable.

Utilisation of Blast Furnace Slag in Highway Improvement. By CLARENCE E. BARDSLEY, Sc.D., Associate Professor of Civil Engineering. (Technical Series Bulletin, Missouri School of Mines, Rolla, Mo.

This bulletin contains 115 pages and 17 illustrations; 8 tables, 39 pages of descriptive matter and a bibliography of 600 references.

The work was undertaken by the Author as a dissertation in partial fulfillment for the degree of Doctor of Science under the National Slag Association Fellowship in Highway Engineering and under the direct supervision of Dr. Arthur H. Blanchard, Professor of Highway Engineering and Highway Transport at the University of Michigan, leave of absence having been granted the Author from the University of Missouri for the year 1926, the latter institution through its School of Mines having printed the paper in abstract form.

Professor Bardsley follows the discussion on the nature and purpose of the investigation with his chapter I., which gives a *résumé* of the History, Manufacture, and Use of Slag as a structural material. He sketches the history of the uses of slag from the earliest Roman times through Germany, England, and other countries in Europe and the Orient to its present uses in the United States. A concise description of the manufacture of slag is taken up from the processes at the blast furnace up to the time it becomes a construction material. Slag as a structural material is then described and its uses discussed. This discussion is concluded by tables summarising the specifications for slag in highway contruction as given in the specifications of many State Highway Departments, the U.S. Bureau of Roads, etc.

Dr. Bardsley's chapter II. discusses tests on blast furnace slag—their interpretations and conclusions. This portion of the report has been abstracted. It is stated that those interested in the actual tests are privileged to examine the full report which contains over 300 pages and is on file in the Library of the Graduate School at the University of Michigan, Ann Arbor, Michigan.

Chapter III summarises on 8 pages his conclusions from the tests mentioned and the general study made, and recommendations are given for further study where little information was available. A symposium of the tests available in this study are given at the end of the chapter.

The next 75 pages of the bulletin comprises the extensive bibliographies on blast furnace slag; the first being given according to kind of publication and alphabetically arranged, and the second consisting almost entirely of a different series of references chronologically arranged.

All in all, Professor Bardsley has ably discussed the possibilities of a road construction material generally little known to engineers, and it looks like at last some use has been found for the great slag heaps one sees along our highways and railroads as one passes through the great pig iron producing centres of the nation.

Copies of this paper may be obtained on application to the Librarian of the Missouri School of Mines, or to the Author. Address requests on letterheads.

Fire Resistant Construction. Department of Scientific and Industrial Research. Building Research Special Report No. 8. Roy. 8vo., ppr wpr., pp. VI + 58, with 27 text figs. and 1 plate. Price 1s. 6d. net. Postage extra.

This report deals with the resistance of building materials to fire. Part I contains a brief outline of the effect of high temperatures upon materials in general, metals, timber, natural stones, bricks, etc.; while Part II is devoted to the fire-resistance of concrete.

The deterioration produced in concrete by fire is shown to be due to two main causes, one being the thermal expansion of the aggregate and the other the presence of free lime, which is dehydrated at the temperature attained in a building conflagration and slakes with expansion on subsequent exposure to moisture, causing complete failure of the structure.

The tests reported show that a good deal of the free lime in Portland cement concrete may be absorbed by the addition of pozzolanas, the resultant concrete showing, in some cases, a considerable degree of stability when eposed to the high temperatures; the value of various pozzolanas for the purpose is discussed.

Research on the lines of the work described in the Report is still proceeding. The special mixtures of Portland cement and pozzolanas have been kept under observation for over two years, both in the normal condition and after exposure to fire, and seem perfectly reliable. A further

report will be published after five year's experience has been obtained.

Copies can be had from H.M. Stationery Offices or any newsagent.

UNION OF SOUTH AFRICA—DEPARTMENT OF AGRICULTURE.

On the Reclamation of Ruined Pasturage on the Amatolas, Nr. Keiskama Hoek.

Prof. S. Schouland, Mon. M.A. (Oxon.), Ph.D., Professor of Botany, etc., deals with this subject in a paper replete with interest for S.A. agriculturists.

The Distribution of Blow-Flies in South Africa.

This subject is dealt with by Bernard Smit, B.Sc (Agric.), M.Sc. (Cornell), and S. Du Pdessas, B.Sc. It is of paramount importance to sheep farmers, for we learn that maggots in sheep has become epidemic in South Africa and is becoming worse, so that every effort should be made to check the plague. We learn that myiasis in sheep was first detected thirty years ago on the east coast, but has now spread all over the country.

Potato Culture. By G. J. BOSMAN, B.S.A., and D. MOSES, M.Sc.

This is a practical and very useful paper. The Authors deal fully with the subject; they give figures shewing the magnitude of the potato crop as compared with other agricultural products, while the principal potato producing countries are given in the order of the magnitude of their products. How to cultivate and fertilise the land, plant and cultivate potatoes, etc., are plainly stated.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

23,037.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of ethers of 6.8-dioxy-quinoline. September 1st.

22,771.—Deltheil, R. — Receptacles for volatile liquids. August 30th.

22,663.—Hailwood, A. J.— Naphthalene derivatives. August 29th.

Specifications Published.

250,211.—Meyerhoffer, A. F.—Process for the production of complex hydrofluoric acids.

26,571.—Soc. of Chemical Industry in Basle.—Manufacture of aromatic tetrahydronophthylamines or derivatives thereof.

269,155.—I. G. Farbenindustrie Akt.-Ges. Manufacture of substituted aromatic sulphonic acids.

269,174.—Jacobson, R.—Method of dissolving aluminiferous raw materials by means of sulphuric acid or acid sulphates.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstracts Published.

274,175.—Amiophenol derivatives.—Chemische Fabrik Grunau Landshoff & Meyer Akt.-Ges., 10, Copernickerstrasse Grunau, near Berlin.

N-monoalkyl-p-aminophenols are made by hydrolysing O-alkyl-N-alkyl-acidyl-*p*-aminophenols with sulphuric acid, under conditions of temperature, time, strength and amount of acid which exclude the formation of sulphonated derivatives. In examples of the limiting conditions, methylphenacetin is heated with 6 equivalents of 50 per cent. sulphuric acid for 3 hours at 139° C., and with 3 equivalents of 70 per cent. acid for 4½ hours at 146° C. A table showing how the various factors may be varied within these limits is given.

273,810.—Recovering waste acetic acid.—Dreyfus, H., 8, Waterloo Place, London.

Waste or dilute acetic acid such as results from the manufacture of cellulose acetate is treated by a reduction process to yield acetaldehyde, which is separated and may then be converted into glacial acetic acid or other concentrated on anhydrous products. The reduction to acetaldehyde is effected by treating the dilute or waste acetic acid in the vapour form with hydrogen or gases containing hydrogen, with or without carbon monoxide, in the presence of catalysts or contact materials. Suitable reduction-promoting catalysts are metals such as nickel, iron, zinc, tin, lead, silver, platinum, palladium, and copper, but other contact materials, such as pumice, glass wool, and sodium chloride may also be used. It is preferred to use an excess of hydrogen.

The acetaldehyde may be separated from the reaction products by fractional condensation. It may then be oxidised by known methods, with or without the use of catalysts, to yield glacial acetic acid, or alternatively it may be treated by the method of Specification 273,622 to yield keten *and/or acetic acid and/or acetic anhydride*. In an example, the vapours of acetic acid of 15-30 per cent. strength are mixed with hydrogen and passed over finely divided nickel at 250-300° C. If a contact material, such as glass wool, is used instead of nickel, the reaction may be effected at a higher temperature, for instance 400° C. The Provisional Specification describes the use *of carbon monoxide instead of hydrogen*.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

NECITHIN.

482,744.—All goods in class 3 which includes chemical substances prepared for use in medicine and pharmacy.—Endocrines, Limited, 72, Wigmore Street, London, W.1. September 7th.

PAVOPIN.

482,918.—Chemical substances prepared for use in medicine and pharmacy.—T. & H. Smith, Limited, Blandfield Chemical Works, Wheatfield Road, Edinburgh. September 7th.

IOTONE.

477,335.—Chemical substances prepared for use in medicine and pharmacy.—Eucryl, Limited, 5, Oakley Road, Shirley, Southampton. September 7th.

KAZEL.

477,880.—Petroleum (not in other classes) for use in manufactures as a substitute for turpentine.—Percy Casswell Ayres, Hatfield, Lower Camden, Chislehurst, Kent. September 7th.

GENERAL INDEX TO THE
"CHEMICAL NEWS"—VOLS. 1 TO 100.

This large volume contains a detailed Index to the first 100 volumes of the *Chemical News*, and will be found of great value to all interested in Chemical, Engineering, Electrical and General Scientific subjects. It has been compiled with great care, is handsomely bound in red cloth, and has been produced at great expenditure of time, labour and money. Carriage paid, Great Britain, 21/- net; Carriage paid to Foreign Countries and the Colonies, 23/- net.

SALE OF PATENT RIGHTS.

The owners of British Patent No. 215012 relating to the Manufacture of New Sulphurised Compounds of Phenol and their application as mordants and No. 224218, Improvements relating to the Dyeing of Cellulose-Acetate Silk are desirous of entering into negotiations with one or more firms in Great Britain for the purpose of exploiting the above invention either by the sale of the Patent Rights or by the grant of a licence or licences to manufacture on royalty.

Enquiries should be addressed to ABEL AND IMRAY, 30, *Southampton Buildings*, London, W.C.2.

ADVERTISER has for DISPOSAL a Stock of recent English and Foreign PERIODICALS, and some Foreign paper-covered Scientific Books at one-quarter or one-third the published price. List on application.—H. E., c/o *Chemical News*.

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THE CHEMICAL NEWS

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THE DEVELOPMENT OF HUMAN PHYSIOLOGY.

By DR. C. G. DOUGLAS, C.M.G., M.C., D.M., F.R.S., *President of the Section.* (*Before the British Association, Leeds, 1927.*)

(*Continued from Last Week.*)

"Thirty years ago Zuntz and Hagemann succeeded in making observations on the output of blood from the heart in a horse by a method which involved operative procedure, though this did not interfere with the animal's capacity for drawing a load, and these experiments afforded the first reasonably definite information as to degree of alteration of the cardiac output caused by vigorous muscular work. More recently methods have been developed for determining the circulation rate in man, and with the help of these we are beginning to find out under different conditions of natural bodily activity the actual quantitative variations in the amount of blood expelled from the heart, the extent of the changes in gas content of the venous blood entering the lungs, and the relative parts played by the two factors of increase in pulse rate and alteration in the systolic discharge at each beat which we have already identified as the potential means by which the heart can respond to alteration in the demands made upon it.

This is, however, only the beginning of our task. To ascertain the full facts of the regulation of the circulation and its adaptation to the varying needs of the body is a more difficult problem than the regulation of the breathing. We may know a little about the behaviour of the heart, but the heart is, after all, only the pump. We have still got to deal with the question of the distribution of the blood to different regions of the body. In spite of all the work that has been done in the past, our ignorance on this side of the question is still profound, and the darkness will not be dispelled until we know much more about what happen in the normal animal. I am not going to assert that human physiology has succeeded in this case in giving us a solution where the method of direct experimentation on lower animals has proved inadequate. It certainly has not as yet, but I do maintain that the knowledge that we have gained from a broad study of the whole respiratory function in man has at least emphasised the nature of the problem that confronts us, and has given us some conception of the difficulties that we have to face. Suppose we expose or stimulate some nerve and find that this leads either directly or reflexly to contraction of the blood vessels in some region of the body. All we have done is to show up a route along which it is possible for vasco-constrictor impulses to travel. We must go much further than this: we must ascertain whether such impulses do follow this route during normal life, and if so, when; what variation may be exhibited in the frequency or strength of the impulses and in the magnitude of the resultant effect; what is the natural stimulus which initiates these impulses and causes them to vary from time to time, and what this variation

may mean to the tissues in the area supplied by the blood vessels in question.

What we have in fa t got to find out are the actual quantitative changes which occur under natural conditions in the general circulation, and then we must try to interpret these in the light not only of our knowledge of the potentialities of the circulatory system itself but in relation also to the varying activities and demands of the tissues.

What matters to the tissues of the body is that each and all of them should at all times be furnished with the right amount of blood to satisfy their needs, however much these needs may vary. The general circulation rate and the calibre of the blood vessels must be accurately adjusted lest in satisfying the needs of some organs others should be starved, and until we can express this adjustment in quantitative terms we cannot hope to assess correctly the relative importance to be attributed to physico-chemical ,nervous or homonal factors in ensuring the necessary co-ordination. We devote enough attention in all conscience to the measurement of blood pressure, and no doubt this has materially aided us to appreciate the cruder and more elementary phenomena associated with the circulation, but when we look at the question from the point of view of the tissues and are brought face to face with the true functional aspect of the circulation, blood pressure as such becomes a more or less irrelevant detail. The failure lies in the fact that we cannot construe our measurements into what is of true functional significance, namely, changes in the rate of blood flow. We cannot of couse expect an adequate supply of blood without an adequate driving force or pressure, but the requisite force at any moment must depend on the precise setting of the calibre of the blood vessels, and in regard to this we must confess that we have still got a vast amount to learn. The adaptation and accommodation of the circulation to meet the requirements of the body is the real essential that we have to study, and it is not until we have gained an insight into the quantitative changes of the local and general circulation, and the factors on which these depend, in the normal and functionally intact animal, that we shall be able to claim to understand the circulation of the blood.

We meet with exactly the same difficulties in the case of the other functions of the body when we try to translate potentialities into actualities. Take the case of the kidney, for example. Controversy has raged for years as to whether the cells in the different regions of the kidney are to be regarded as playing an active or a passive role in the formation of urine. Observations on the anæsthetised animal or the isolated kidney are slowly solving some of the difficulties, but even when we have reached agreement on the vexed question as to the degree to which the properties of filtration, active re-absorption and specific secretion can be ascribed to the kidney epithelium we are only at the beginning of our troubles, for we have still to ascertain how these different potentialities may be brought into play to account for the normal behaviour of the kidney. Observations on man have already done much to show the surprising delicacy with which the kidney *responds to alterations in the composition* of the blood, and to throw suspicion on the justice of conclusions based on experimental alterations of so gross a character that they could have no counterpart in normal life. The kidney is not acting as a simple drain; it is playing a perfectly definite part in helping to maintain the composition of the blood normal, and experiments on human subjects have thrown into strong relief the interdependence of the kidney and other organs in maintaining this normality.

The physiological regulation of the hydrogen ion concentration of the blood and tissues, a problem to which so much attention has been directed in recent years, affords an instance of the interaction of the organs in promoting the normal working of the body. We cannot restrict ourselves here to a consideration only of the physico-chemical properties of the blood and tissue fluids, for the initiation of any alteration in the hydrogen ion concentration of the blood will at once result in a change in the activity of the respiratory, circulatory and excretory organs, the net effect of which will be to render the actual change of hydrogen ion concentration a great deal less than would otherwise be the case. Thus we see that the reactions provoked in response to changed conditions will tend to preserve the functional capacity of the body by limiting the changes in the immediate environment of the tissue cells.

The experimental investigation of man has furnished the clearest evidence of co-ordination of organ activity of this type. The reaction to muscular wor kis a case in point, for the increased activity of the respiration and circulation, by hastening the elimination of CO_2 from the body, helps to keep within reasonable limits the rise of

hydrogen ion concentration in the blood caused by the passage of greatly increased amounts of CO_2, and even lactic acid, from the active muscles into the blood stream, and at the same time maintains the oxygen supply. The limitation of the changes of hydrogen ion concentration in the blood, which is brought about by simultaneous changes in the activity of the respiratory centre and in the rate of excretion of acid and basic radicals by the kidney, has been demonstrated in man when acid or alkali is temporarily withdrawn from the body during the secretion of the digestive juices just as clearly as when an excess of acid or alkali gains admission to the body owing either to alteration of the diet or to the deliberate ingestion of alkalies, such as sodium bicarbonate, or substances, such as ammonium chloride, which lead to the liberation of acid within the body. There is evidence, too, from experiments on man that in the tissues themselves a still narrower limitation of changes of hydrogen ion concentration than in the arterial blood may be attained by local acceleration or retardation of the circulation.

In the influence of training on a man's capacity for strenuous muscular exertion, and in the proces of acclimatisation to the reduced oxygen pressure in the atmosphere at high altitudes—a process to which changes in the activity of the respiratory organs and kidneys and in the composition of the blood all contribute—we get further examples of the co-ordinated accommodation of organ activity to alteration in the conditions of life.

The more we examine the normal behaviour of the body the more is it brought home to us that the maintenance of the natural life and integrity of the organism depends on the closest co-ordination of all its different parts; all the organs are interdependent, and can have no real existence save as active components of a corporate whole. Life consists of a delicate balance of all the different functions, a balance that is being continually adjusted so as to ensure the maintenance of the true functional capacity of the organism in its struggle for self-preservation in a constantly varying environment. As an agent in securing this exquisite co-ordination a physico-chemical change in the blood stream may at one moment be prominent, at another moment a nervous reflex. Very frequently both factors co-operate, the physico-chemical change ensuring perhaps strict quantitative co-ordination of activity, the nervous reflex offering the advantage of speed and simultaneity of response in parts of the body remote from one another. The two factors are not antagonistic; the one is not gradually supplanting the other, but each plays its part in its own peculiar sphere.

When we recognise the exactness of the co-ordination of the different functions in normal life we cannot fail to appreciate the relative crudity of some of the experimental methods we are forced to use in physiology. Methods that interfere with the mutual interdependence of the different organs can only give us a partial insight into the problem of life, and if we use these methods we must correct the impression that we gain by comparison with the true normal.

In attempting to put before you what appear to me the outstanding contributions which we owe to human physiology—the quantitative changes of organ activity associated with normal life, the close functional linkage of the different organs, and the power of adaptation to altered circumstances—I have, as is only natural, dwelt upon those branches of physiology with which I personally have been mainly brought in contact. But the study of human physiology is by no means limited to these fields, and we must not forget that we owe much to work undertaken primarily in the cause of clinical medicine, a debt which we can repay in part as we develop new methods by which we may investigate the physiology of man. Instances of spontaneous derangement of function in man have helped very considerably to elucidate the influence of the ductless glands, and modern methods of clinical examination have amplified our knowledge of the processes of digestion and the movements of the alimentary canal; while the neurologist is widening the field in which we can find scope for the application of the fundamental principles of reflex action which, based originally on the experimental investigation and analysis of the properties of the lower nervous system, have already been extended by the physiologist to embrace some at least of the functions of the cerebral hemispheres in the intact animal.

When we review the development of physiological thought in the last quarter of a century we cannot close our eyes to the fact that investigations on man are becoming of increasing importance, and that the contribution made by human physiology does not involve mere matters of detail. There is something of far more importance

than that, for the evidence of balanced interaction of the functions of the different organs with the preservation of the functional integrity of the whole, which is so convincingly brought home to us in experiments on the human subject, has made us appreciate that in physiology the organism as such, be it man or one of the lower animals, in our unit, and that, whatever methods we may employ in our investigations ,we must keep that essential fact before us. In the problem of what is meant by life we have set ourselves the most complicated puzzle in existence. I firmly believe that human physiology, limited though our knowledge may as yet be, has already given us a vague glimpse of the final picture which we hope to complete, and has put us in a better position to fit together the individual fragments, the tiny components of the puzzle, which we have been accumulating in such profusion in years past.

The truth is that we cannot confine ourselves exclusively to any one method in physiological investigation. Unless we deliberately study the normal organism in its entirety I do not see how we can gain any adequate conception about what is really implied by life, but once we have begun to gain that conception we can employ the methods of detailed analysis about which I have spoken earlier with hope of real success. There has been a tendency of late to differentiate the subject of bio-chemistry from physiology, but this distinction, though it may have the merit of administrative convenience, can have no real justification if the ultimate aim of the physiologist and bio-chemist is, as I suppose, the same, namely the investigation of the nature of living processes. Physiology and bio-chemistry in fact merge into one another, and if we call to our aid the resources of chemistry and physics that need not imply that we are any the less physiologists, but we have to be on our guard that we do not by imperceptible degrees turn from the path of biology into that of pure chemistry and, in so doing, miss the goal that we set out to attain. If an example is needed of the application of chemical and physical methods of investigation to the normal living organism, I would point to the work that has been done on human physiology, for it seems to me that a just claim may be made that in that there is represented at least one aspect of true chemical physiology.

I have now tried to show you something of the part that has already been played by human physiology in the study of the phenoment associated with life, and I want to turn to a different aspect with a view to urging a wider extension of the study of this branch of physiology. In our enthusiasm for research we are apt to overlook the fact that unless our teaching can keep pace with our research the general advance of learning must be seriously impeded. Age must give place to youth, and we must do our best to hand on to those who will succeed us the knowledge which we have interited and to which we have added in our own generation, so that they may be able to go forward from the point where we are obliged to leave off.

I cannot help feeling that our teaching of physiology would be more satisfactory if human physiology occupied a more prominent position. I am not thinking so much in this connection of advanced teaching, for the number of students who take advanced courses is relatively small and it is fairly easy to arrange suitable work for limited numbers. The great majority of students who take up the study of physiology do so as a preliminary to a medical career, and but few of them in the end pass on to advanced courses, and it is of the elementary teaching of physiology required as a preliminary to the study of clinical medicine, or an antecedent to more advanced honours courses, that I wish to speak.

So far as the theoretical side of physiology is concerned, books enough and to spare are available; and if the student is dissatisfied with his text book or his teachers he can turn, unless he is appalled at the prospect, to the ever-increasing number of monographs, reviews and special volumes which offer him information on almost every conceivable branch, however obscure, of physiology. It is, I think, the practical instruction in physiology with which we may legitimately find fault. We are, I suppose, in part tied by tradition, in part hancidapped in our laboratories by the accumulation of apparatus of bygone days, and it is easy to point to lack of funds as an excuse for continuing in the same path as those who preceded us. The fact remains that so far as elementary practical physiology, as distinct from bio-chemistry, is concerned, reliance is still largely placed upon an experimental treatment of some of the rudimentary phenomena exhibited by amphibian muscle and nerve. I do not deny that some of these experiments do afford in-

formation which is of value to the student, but I am also prepared to maintain that others are only artificial, and but relics of the past that would be better omitted, and that they in no way represent the standpoint of the present day in this branch of physiology. But though experiments on muscle and nerve still figure largely in the physiological curriculum, it is noticeable that simple experiments illustrating the progress of more recent years are gradually being introduced, and that in some laboratories a far more serious attempt has been made to remodel the curriculum than in others, and to afford an opportunity for gaining acquaintance with some of the facts of human physiology.

Such a change in outlook is very welcome. When dealing with a subject which is so rapidly progressive as physiology I feel that we are bound to consider our methods of teaching at intervals, if we are to render those whom we instruct reasonably conversant with the actual state of knowledge at the time; mere addition to the curriculum is of no use, what is needed is reconstruction. Do not think that I say this in any carping spirit. After all, some facts have become so firmly established in the past as to have become axiomatic, and we must be content to accept many of these without constant repetition of their proof if time is to be found to give the student some indication of the experimental developments which have led to alteration and extension of our earlier conceptions. If practical courses of instruction are to play their full part and not to degenerate into simple exercises in skilful manipulation they must be brought into line with current physiological thought; they must, even though the experiments be simple, help to convince the student of the meaning and truth of what he reads. I am certain myself that a serious attempt to incorporate even in elementary courses experiments on human physiology will be amply justified.

I confess frankly that in my own case if I want to understand the facts of physiology I have to think of what they might mean to me in my own person; I cannot think easily in terms of lower animals. I have got to translate the information before I can use it. I do not believe that I am peculiar in this respect. Many a student would, I am sure, acquire a deeper and more real interest in physiology if his attention was directed to some of the essential facts of human physiology at an early stage in his instruction. Show him something of what really happens in himself in the natural course of his daily life ,awaken his curiosity about the way in which these events are actually accomplished, and he will then more readily understand the significance of what he learn from other sources. As it is, he runs the risk of being overwhelmed by the literature of the subject that he is studying and of losing himself in details which he cannot place in the right perspective; he too often fails to see the wood for the trees. The quantitative interdependence of function in the body can be well illustrated by simple experiments in human physiology, and a more convincing introduction to those quantitative conceptions which must form the basis of physiology, as of other branches of natural science, can be gained, I think, in this way than by, say, a few quantitative bio-chemical analyses which, essential thought they may be in themselves, can hardly be more than exercises in method in the early days of a student's career.

These students are for the most part going to follow the profession of medicine, and in the short time available our aim must be to develop their powers of thought and initiative that they may be the better equipped to face the future when they go out into the world; and if they leave us with only the recollection of a medley of seemingly disconnected facts, it is quite intelligible that they may fail to grasp what physiology really means, and that a gulf, for which there can be no justification, will deepen between physiology and medicine. Physiology is not medicine: the physician sees a side of life which the physiologist does not meet in the cold aloofness of the laboratory. The art of medicine is not based merely on the application of skilled technique; it demands in addition a full and sympathetic comprehension of human nature with all its hopes and fears, its frailty and courage. And yet the more the physiologist can find out about the characteristics of normal life the greater will be his service to medicine, for a knowledge of the normal cannot but help us to estimate with greater certainty the influence of the abnormal, and the underlying principles of adaptation of organ activity which we as physiologists recognise in the functional changes which exhibit themselves in everyday life, and in the reactions to alterations of environment, have their counterpart in medicine in the natural efforts at compensation for the effects of injury or disease, a

compensation which it must be the aim of the physician to encourage and assist.

And there is another field in which scope may be found for human physiology. In the growing complexity of the modern world the improvement of the general standard of life is a matter which appeals to all of us. Physiologists have already played a prominent part in investigations into the means by which conditions may be imroved and risk reduced in industrial processes, into the factors which affect the efficiency and welfare of the working classes, and into the influence of diet on health. Problems such as these, whose solution is of direct benefit to the community at large, call for the practical application of physiological principles. We ought not to regard applied physiology as something distinct, as something to be divorced from the more academic study of theoretical physiology; it should be looked upon as the natural extension of our researches in the laboratory. These practical problems in their turn often suggest new lines of inquiry, new methods of approach, by which the science of physiology may be still further advanced.

The horizon stretching before the physiologist is a wide one, and, no matter whether he intends to adopt an academic career in pure physiology or to follow the path which leads on to medicine or to hygiene in its broadest sense, I am convinced that a study of human physiology will introduce him to some of the fundamental facts of life, and by giving him a guiding line of thought will help him to make his way through a maze of minutiæ and speculations in which he might otherwise get overwhelmed.

REDUCTION OF COPPER SULPHATE BY SODIUM HYPOPHOSPHITE.

By S. Ramachandran.

General.

Dr. Caven, in his "Systematic Qualitative Analysis," page 221, suggests the following experiment to distinguish between hypophosphites and phosphites :—

"Add neutral hypophosphites to copper sulphate; there is no precipitate, but, on heating, brown cuprous hydride is precipitated."

The author of this note repeated the above-mentioned experiment a number of times, but his persistent failure to obtain the result suggested this brief investigation.

Experimental.

Two per cent. solutions of both hydrated copper sulphate and neutral sodium hypophosphite were used throughout.

(1) 5 c.c. of each of the two solutions were mixed and raised to the boiling-point. No radical change was noticed, except a slight cloudiness of the mixture which does not deepen even after allowing to stand for a long time.

(2) 5 c.c. of each of the two solutions were mixed and two to three drops of pure dilute sulphuric acid added. The temperature of the mixture was gradually raised when it was observed that it becomes cloudy at about 66° C., indicating that the reduction of the copper sulphate commences in the vicinity of that temperature and is complete on allowing to stand for a few minutes. A reddish-brown precipitate is obtained.

(3) Experiment (2) was repeated with 5 c.c. of the copper sulphate and 10 c.c. of the hypophosphite. The temperature of reduction was found to be about 72° C.

(4) Experiment (2) was performed but with the addition of two or three drops of very dilute hydrochloric acid. The solution became cloudy with precipitation of a somewhat white precipitate and then a somewhat red precipitate is formed—the temperature of reduction being noted to be in the vicinity of 80° C.

(5) An experiment similar to (4) was made but with 5 c.c. of copper sulphate and 10 c.c. of hypophosphite to which a few drops of dilute hydrochlorie acid had been added. The temperature of reduction was noted to be about 85° C.

Conclusion.

The above experiments were repeated a number of times and the author of this very brief note had been irresistably drawn to the following conclusions from them :—

(1) The reduction of copper sulphate by Sodium hyphosphite takes place only when the resultant solution is distinctly acidic.

(2) The Hydrion concentration in the mixture has to attain a definite value before the reduction is effected.

(3) The temperature of the reduction is higher the larger the amount of hypophosphite present to the same amount of copper sulphate.

Problems.

A few of the problems suggested by this experiment are noted here, in conclusion, and, it is hoped, that time and opportunity

will enable the author to arrive at satisfactory solutions of them :—

(1) Determination of the exact value of the hydrogen-ion concentration.

(2) The effect of the addition of larger quantities of acid to the same quantity of the reacting mixture to note whether any change in the temperature of reduction is noted.

(3) The role played by hydrochloric acid in first giving a white precipitate and then a reddish-brown precipitate.

(4) The effect of increasing the amount of hypophosphite is bringing about the reduction at increased temperatures.

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8 August, 1927.

AN ATOMIC MODEL FOR THE CHEMIST.—VI.

By FLORENCE LANGWORTHY.

We are told that when ions are made the atom has one of its outer electrons knocked off it and thereby becomes ionised. This leaves us with an ionised atom—which is positive because it has lost an electron—and a negative ion (an electron). But there is much evidence to show that the matter is not so simple as that save in the case of the neutral hydrogen atom where the electron may be repelled away from its positive or — what is more probable — tempted away by some newly-ionised atom. Our atomic model shows us that when an atom is ionised by means of irradiating it with X-rays or rays from the violet end of the spectrum, it does not merely lose an electron but gains two more in place of the one lost and a positive as well. Consider the following :— "Townsend found that the value of ne for the positive ion came out about 14 per cent. higher than the value of this quantity for the univalent ion in electrolysis, a result which he did not seem at first to have regarded as inexplicable on the basis of experimental uncertainties in his method. In 1908, however, he devised a second method of measuring the ratio of the mobility and the diffusion coefficient and obtained this time, as before, for the negative ion, $ne = 1.23 \times 10^{10}$, but for the positive ion twice that amount, namely 2.46×10^{10}. From these last experiments he concluded that the positive ions in gases ionised by X-rays carried on the average twice the charge carried by the univalent ion in electrolysis. Franck and Westphal, however, found in their work that Townsend's original value for ne for the positive ions was about right, and hence concluded that only about 9 per cent. of the positive ions could carry a charge of value $2e$."* Here we are shown that ionisation by X-rays is different from the ionisation that takes place in electrolysis when a positive atom and a negative atom part company. We are not concerned with the number of ions that Townsend found, what concerns us is that he found double-positives. We know that the Alpha ray is a double-positive, but here we are not considering an exceptional ion like this but ordinary atoms that have become ionised. We have seen that the Alpha ray on gaining a negative particle—not two electrons simply—becomes an atom of helium. As an Alpha ray it can hold up two distant electrons and still be a double-positive even as the Hydrogen A atom can hold up a distant electron and still be a positive. But to return to ordinary atoms, Professor Millikan —as before mentioned—has drawn attention to the fact that is these cases one electron and one only is yielded whether the atom be of heavy weight or light. So it cannot be argued that these atoms are double-positives because two electrons have been knocked out of them. Sir Joseph Thomson has shown us that even oxygen has its double-positive ray. In the second-order lines we apparently have indicated that brief space in which the two positives are both excited to such a pitch as to be pulling equally upon the coronal electrons and thus halving the atomic weight. Thus we can picture an atom of lithium of mass 6 as absorbing the X-ray that will change it to mass 7. For a few moments, however, while the two positives are equally excited that mass instead of being 7 will be $3\frac{1}{2}$. But this temporary excitement on the part of the new-born positive will have subsided by the time it begins to unite with a negative atom as such. When, for instance, the sodium atom unites—as a positive—with the chlorine atom it will have its full weight and it will not have a double-positive charge since only the outer positive, the isotope positive, will be excited.

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* *The Electron*, by Robert Andrews Millikan, p. 39. (2nd Edition.)

Why do the leaves of an electroscope that is negatively charged collapse under a beam of ultra-violet light while there is no such effect if the charge is positive? Surely the answer is that the ultra-violet rays have turned some of the negatives into positives and thus neutralised the leaves. If, however ,the leaves had been positively charged the ultra-violet rays could have only added to the positivism by splitting up still more neutral molecules by turning one or both partners into double-positives.

From this point of view let us consider a recent article by Professor MacBride on "Variety and Environment in Lizards" (*Nature*, July 16, 1927). Professor MacBride writes:— "Kammerer shows that healthy young Lacerta Serpa of typical green colour can be rendered quite dark if exposed for 1½ to 2 years to strong radiation reflected from stones. . . . Not only did Kammerer blacken green lizards by exposing them to dryness and radiant heat, but he recalled the black lizards of Melisello to their ancestral green colour by keeping them for two generations in a cool and moist atmosphere. He analyses the anatomical bases of the colour. There are three pigments—a yellowish-red lipochrome, melanin, and lastly, guanin, which produces the blue colour by interference effects. The green is due to the combined effects of the guanin and lipochrome. He shows that as the temperature of the vivarium is increased, first the lipochrome and then the guanin is destroyed, and the melanin extends its range. This state of affairs is reached at 37° C. As the temperature is increased to 39° C, which is the utmost the lizards can stand, the melanin disappears and a bleached albino results."

We may well suspect the rays at the violet end of the sun's spectrum as being the cause of this change—they and the secondary radiation from the rocks to which they give rise. Let us picture an ultra-violet ray as penetrating one of the silicon atoms of the rocky surface. It turns the same into a double-positive and an electron is expelled. If the atmosphere had been moist then that electron as a negative ion would have immediately attracted to itself a molecule or so of water vapour and so would have been put out of action so far as penetrating one of the atoms of a lizard's body is concerned. But the atmosphere is dry and so this bullet is able to find a billet, and thus causes an X-ray to be radiated. We will picture this X-ray as entering another atom and so turning it into a double-positive. Thus by degrees many of the atoms will become double-positives. The pigment that will be formed will contain not only the negatives that reflect the green rays and pass the red, but also the double-positives that reflect the red rays and pass the green. In melanin we apparently have such a pigment. The animals in which it is developed will be black because the negative atoms are passing the red rays while the positive atoms are passing the green and violet rays. We shall therefore have black lizards instead of green ones. When, however the lizards are, as it were, at their last gasp, Nature, it would seem comes to their rescue by developing a pigment in which the atoms are oriented in such a fashion that neither the red nor the green rays can pass but all are reflected and so the animal is white.

That the lizards should increase in size on becoming black we can also understand since atoms on becoming double-positives—and so gaining an isotope—will increase in size. The negative atom will have absorbed a ray that has turned it into a double-positive, so we shall have an atom minus one electron but plus a positive and two electrons.

For the making of pigment the eye seems to be peculiarly sensitive. I quote the following from Sir James Crichton-Browne's most interesting book, *Stray Leaves from a Physician's Portfolio*, p. 197):—

"The Amphibia. . . have naked skins and complex and sensitive eyes and they have, moreover, movable pigments in their skins which respond to light, giving rise to changes in colour. These pigments, black, red, yellow or green, are contained in cells called chromataphores, placed immediately beneath the transparent epidermis, and these cells can contract, withdrawing the pigment from the surface and making it look pale, or dilate and spread it out near the surface, giving it a darker or more saturated tint. By the movement of these chromatophores in conjunction with a fixed white pigment, and with interference of light by structure, producing blue and violet colours, these creatures, and especially the chameleons and tree frogs, appear in many varied and beautiful liveries, which are changed in accordance with environment and disposition. The paramount object of these varied liveries is concealment, and so the animal assumes a pattern skin to its surroundings. What has been called natural photography goes on. The frog that sits on the grass or amongst green leaves grows green, the frog located on granitic soil becomes [illegible]

haunting a dark moorland dons a brown costume. These changes, which are slowly established, are attributable to the influence of light and colour playing directly on the skin, but other more rapid changes, as Lord Lister long ago proved, are produced, not by the direct action of light on the skin, but indirectly by its action on the optic nerve and retina."

When we remember that the world during all the years that witnessed the evolution of species was a vastly different place from what it is now, that Western Europe, for instance, was largely given over to forest and swamps, we can understand that the Amphibia are still in a state of transition. Evolved in an atmosphere saturated with moisture the frog is still in process of adapting himself to a world that has more or less lost its moist atmosphere. Sitting among the green leaves of a sheltering tree with plenty of moisture about to render harmless any electrons struck out of atoms, the frog is hardly running any more risk than did his ancestors when all the world was young. But when he is forced out from the friendly forest or the friendly swamp and is exposed to the cruel sunlight on a rocky soil or a shadeless moorland, then he may well develop a different pigment.

Let us also consider the following words of Sir James Paget on the decay of leaves :

" It is marked chiefly by their change of colour—the changes to which we owe the characteristic beauties of our autumn scenery. These are accompanied by changes of texture, shown in the dryness and brittleness of the leaves, and by changes of chemical composition, but I refer only to the changes of colour. And observe that these indicate decay not death. They do not occur when fresh leaves are quickly killed ,as in hot water or when they are pressed and dried for a herbarium."*

We can see then, that it is highly probable that not only trees, but men, lived much longer in those old days when the atmosphere was saturated with moisture. There is little now to protect us against the shafts of Apollo and so we decay like the leaves of a tree, lasting only, comparatively, a few more hot summers.

We have now to ask ourselves why the leaves whose greens have been turned to reds, whose negatives have become positives, should become dry and brittle in the process. We have seen that the negative ion attracts the molecule of water vapour and therefore the positive is not likely to attract the same, but rather to repel it. It has been noted that in places where steam is let off such as railway stations you get your positives in excess. The molecule of water vapour is undoubtedly positive, as we should expect, seeing that there are two positive atoms to one negative. Our leaves, therefore, that have turned red and orange owing to the change that has turned their negatives into positives may well become also dry and brittle.

* *Sir James Paget*, by Stephen Paget, p. 300.

GENERAL NOTES.

IGNITION OF GASES.

It is known that inflammable gases can sometimes be ignited by a heated wire. A research described in the Safety in Mines Research Board Paper No. 6 (" The Ignition of Gases by Hot Wires," by W. C. F. Shepherd and R. V. Wheeler, H. M. Stationery Office, price 1s.) was undertaken to discover to what extent the glowing tungsten filament of a 2 volt miner's electric lamp-bulb might constitute a source of danger in a coal mine by reason of its possible ability to cause the ignition of mixtures of firedamp and air. It was found that the ignition of firedamp in this manner was a likely danger.

WHOLESALE PRICES IN FRANCE, BELGIUM, GERMANY AND ITALY.

The index numbers of wholesale prices in France and Italy, which had been following a downward course for several months, declined further in July by 0.5 per cent., and 1.4 per cent., respectively. The German and Belgian index numbers, which had advanced in May and June, also showed a small decline in July.

BRITISH STANDARD DRAWING OFFICE PRACTICE.

Recommendations for British standard drawing office practice, dealing with a standard procedure for submitting drawings, tracings and blue prints, to be adopted by manufacturers and contractors, have just been published by the British Engineering Standards Association. This publication (No. 08-1927) is of considerable interest to

all those engaged in industries where drawings are used. Considerable care has been expended by the Committee in its preparation, so that no hardship should fall on any firms should the recommendations contained in the Report not be in strict accordance with their usual practice. The scope of the Report covers the overall sizes of tracing cloth and paper, position of drawing number, date and name, indication of scale, method of projection, types of lines and writing, dimension figures, relative importance of dimensions, indication of material on drawings, screw-threads, flats and squares and tapers, together with explanatory diagrams.

Copies of the Report may be obtained from the British Engineering Standards Association, 28, Victoria Street, London, S.W.1.

IRISH FREE STATE.

Registration of Patents, Designs and Trade Marks.

The attention of owners of patents, designs and trade marks registered in this country is drawn to the provisions of the Irish Free State Industrial and Commercial Property (Protection) Act, 1927, which will come into full operation on 1st October, 1927.

This Act repeals the United Kingdom Patents, Designs and Trade Marks Acts in so far as they are in force in the Irish Free State, and establishes Registers for the separate registration of patents, designs and trade marks in the Free State.

By Sections 29, 66 and 89 of the Act special provision is made for the registration of patents granted by the Patent Office in London bearing date prior to 1 October, 1927, and of trade marks and designs registered in the Patent Office in London before that date. Applications for the registration of patents under Section 29 must be made before the first renewal fee payable in the Irish Free State becomes due, but if such fee becomes due before 1 April, 1928, the Comptroller may, on application, extend the time for payment of the fee up to that date. In the case of trade marks and designs, the application for registration under Section 89 or Section 66 must be made before 1 April, 1928.

The forms to be used in applying for registration, and the fees to be paid, will be prescribed by Rules under the Act.

Copy of the Act may be consulted in the Public Library of the Patent Office, 25, Southampton Buildings, Chancery Lane, London, W.C.2. Copies can also be purpurchased from Messrs. Eason and Son, Ltd., 40 and 41, Lower O'Connell Street, Dublin, price 2s. net.

BOARD OF TRADE ANNOUNCEMENT.

Safeguarding of Key Industries.

The Board of Trade give notice that representations have been made to them under Section 10 (5) of the Finance Act, 1926, regarding Bromural (Monobromisovalerylurea); Eukodal (Dihydro codeinone hydrochlorate); Papaverine; R Potassium permanganate; Resorcine; and Styracol (Guaiacol cinnamate).

Section 10 (5) of the Finance Act, 1926, is as follows :—

"The Treasury may by order exempt from the duty imposed by section one of the Safeguarding of Industries Act, 1921, as amended by this Act, for such period as may be specified in the order, any article in respect of which the Board of Trade are satisfied on a representation made by a consumer of that article that the article is not made in any part of His Majesty's Dominions in quantities which are substantial having regard to the consumption of that article for the time being in the United Kingdom, and that there is no reasonable probability that the article will within a reasonable period be made in His Majesty's Dominions in such substantial quantities."

Any person desiring to communicate with the Board of Trade with respect to the above-mentioned applications should do so by letter addressed to the Principal Assistant Secretary, Industries and Manufactures Department, Board of Trade, Great George Street, S.W.1., within one month from the date of this notice.

21st September, 1927.

DISCOVERY OF SILVER ORE MADE NEAR GOUDREAU, QUEBEC.

Goudreau is widely excited over a new find of silver ore by Mr. William Kozak, of Gourdreau, Quebec, whose eight claims have been optioned to the Nipissing Mines for a figure in excess, it is stated, of $100,000. The find was made some weeks ago at mile 174 on the Algoma Central Railway, three miles south of Goudreau.

TRANSPORT CHARGES ON EXPORT COAL.

Mr. Philip Gee, Director of the Colliery Owners' Publicity Department, issues the following statement :—

Sir William Sutherland has recently drawn attention to the burden placed upon the British export industries by the sheltered trades and has suggested that a reduction in transport charges on coal from 60 per cent. to 30 per cent. above the pre-war scale would enable a reduction of 1s. a ton to be made in f.o.b. prices in numbers of cases and would give a great impetus to the coal trade.

In certain quarters Sir William's statement has been challenged and it has been suggested that there is not much scope for reduction in railway rates, and that a reduction of 1s. a ton would not be of much assistance. The latter claim is scarcely worth contesting except with the obvious statement that such a reduction would be of enormous assistance to our exporters, but the following figures show that the situation is even more serious than Sir William indicated and that " transport " charges include other items besides the actual railway rate.

In South Wales these charges compare with those in force before the war as follows :

	1913		1927		Increase in 1927 over 1913	
	s.	d.	s.	d.	s.	d.
Railway Rate ...		$11\frac{3}{4}$	1	9		$9\frac{1}{4}$
Wagon hire ...		$4\frac{1}{2}$		$6\frac{3}{4}$		$2\frac{1}{4}$
Wharfage and tipping charges ...		$4\frac{1}{4}$		$10\frac{1}{2}$		$6\frac{1}{4}$
	1	$8\frac{1}{2}$	3	$2\frac{1}{4}$	1	$5\frac{3}{4}$

The percentage increase is 87 per cent. not including certain extra charges for washed duff, etc. In South Wales the wagons belong to the collieries and the increase in the items for which the Railway Companies are responsible is 98 per cent.

It would seem that the transport price (average) of coal is 76 per cent. above the prewar charge, although the index number of wholesale plices is only 40 per cent. and the index number of coal prices is only 20 per cent. above pre-war prices, while shipping freights are actually under pre-war index.

MUNICIPAL COLLEGE OF TECHNOLOGY, MANCHESTER.

(UNIVERSITY OF MANCHESTER).

We have to acknowledge the prospectus of the above Institution, which extends to no fewer than 310 pages. There is given detailed information of the various departments and courses, list of Professors, lectures, graduates, associates, etc. As regards applied chemistry, we notice that the chemical laboratories comprise : The Inorganic Laboratories, with bench space for 156 students working simultaneously; the Organic Laboratory, with bench space for 88 students; the Physical-Chemical Laboratory; the Gas Analysis Laboratory; the Water Analysis Laboratory; special laboratories, for research and technical work, and a laboratory on the roof of the building in which chemical and technical operations of an exceptional character can be conveniently performed.

All the laboratories are liberally equipped with modern apparatus and appliances required for purposes of instruction as well as for research work.

ROYAL SOCIETY OF ARTS.

COMPETITION OF INDUSTRIAL DESIGNS.

1927.

Number of Entries.

The total number of competitors who entered for the various sections of the Competition was 745. Of these, 571 were students of Schools of Art, and 174 non-students.

The number of designs submitted was 2,224, divided as follows :—

Architectural Decoration	224
Textiles	487
Furniture	101
Book Production	220
Pottery and Glass	318
Miscellaneous—	
Messrs. Cadbury Brothers, Ltd. ...	51
Messrs. Bryant & May, Ltd	202
Messrs. J. S. Fry & Sons, Ltd. ...	236
Messrs. Fryer & Co. (Nelson), Ltd.	91
Messrs. Henley's Tyre & Rubber Co. Ltd.	123
Messrs. Rowntree & Co., Ltd. ...	11
Underground Group of Companies	182
Messrs. Hugon & Co., Ltd.	28
Total ...	2,224

APPENDIX TO REPORT.

The Report on the Competition of Industrial Designs for 1926 contained a complete

list of the subscriptions to the Prize and Scholarship Fund for the years 1924-26. This year a great many of the larger prizes have been offered by manufacturing firms for designs for special purposes. In several cases the judges did not consider the work submitted deserving of the full awards. The amounts offered by the firms are given in the list below, and the amounts actually awarded are printed in brackets.

SECTION I.—ARCHITECTURAL DECORATION.

	£	s.	d.
Royal Society of Arts (under the John Stock Trust) (no award)	50	0	0
Royal Society of Arts (under the Mulready Trust)	20	0	0
Messrs. Bagues, Ltd.... ...	50	0	0
A. W. Martyn, Esq.	2	0	0
Arthur J. Davis, Esq., F.R.I.B.A. (Chairman of the Sectional Committee)	20	0	0
Messrs. Hailwood and Best, Ltd.	10	10	0
Messrs. Shuffrey & Co. (no award)	5	5	0
Messrs. Lewis Berger & Sons, Ltd.	60	0	0
	£240	15	0

SECTION II.—TEXTILES.

	£	s.	d.
Messrs. Warner & Sons (£10)...	45	0	0
Messrs. Arthur H. Lee & Sons, Ltd.	100	0	0
Messrs. Simpson & Godlee, Ltd.	105	0	0
The Carpet Manufacturing Co., Ltd.	30	0	0
Messrs. Hay & Robertson, Ltd.	25	0	0
The Tootal Broadhurst Lee Company, Ltd.	75	0	0
Donations to the General Prize Fund.			
Messrs. Turnbull and Stockdale	25	0	0
Thomas Muddiman, Esq.	5	5	0
The Weavers' Company	5	5	0
A. F. Kendrick, Esq.	1	1	0
	£416	11	0

SECTION III.—FURNITURE.

	£	s.	d.
Messrs. W. Turner Lord & Co. (£11 11s.)	25	0	0
Messrs. Waring and Gillow, Ltd. (£11 11s.)	25	0	0
Messrs. Green and Abbott, Ltd. (£10 10s.)	25	0	0
Messrs. Frederick Tibbenham,			
Donations to the General Prize Fund.			
Sir Bignell G. Elliott, K.B.E....	5	0	0
	£105	0	0

SECTION IV.—BOOK PRODUCTION.

Donations to the General Prize Fund.

	£	s.	d.
Federation of Master Printers	15	15	0
Master Bookbinders' Association	15	15	0
Messrs. John Dickinson & Co., Ltd.	10	10	0
Messrs. W. H. Smith & Sons, Ltd.	10	10	0
Messrs. Longmans' Green & Co., Ltd.	10	0	0
Messrs. Henry Stone & Son, Ltd.	10	0	0
Messrs. George Barber ...	5	5	0
Sir John Murray, K.C.V.O. ...	5	0	0
The Stationers' Company	4	4	0
Cambridge University Press ...	2	2	0
Messrs. Hazell, Watson & Viney, Ltd.	2	2	0
C. J. LE'strange, Esq.	2	2	0
James MacLehose, Esq., LL.D., F.S.A.	2	2	0
The Medici Society, Ltd. ...	2	2	0
Messrs. Waterlow & Sons, Ltd.	2	2	0
Messrs. B. T. Batsford, Ltd....	1	1	0
Messrs. Chatto and Windus ...	1	1	0
C. T. Jacobi, Esq.	1	1	0
Messrs. Robert Rivière & Son, Ltd.	1	1	0
Messrs. Hodder & Stoughton, Ltd.	1	0	0
	£104	15	0

SECTION V.—POTTERY AND GLASS.

	£	s.	d.
Goldsmith's Company (£47 5s.)	63	0	0

SECTION VI.—MISCELLANEOUS.

	£	s.	d.
Messrs. Cadbury Brothers, Ltd.	50	0	0
Messrs. Bryant & May, Ltd. ...	31	10	0
Messrs. J. S. Fry & Sons, Ltd.	75	0	0
Messrs. Fryer & Co. (Nelson) Ltd.	50	0	0
Henley's Tyre and Rubber Co., Ltd.	50	0	0
Messrs. Rowntree & Co., Ltd. (£25)	40	0	0
The Underground Group of Companies	31	10	0
Messrs. Hugon & Co., Ltd. ...	10	0	0
	£338	0	0
Grant Total ...	£1,205	6	0

THE EQUILIBRIUM DIAGRAM OF COPPER-TIN ALLOYS CONTAINING FROM 10 TO 25 ATOMIC PER CENT. OF TIN.

By A. R. Raper, B.A.
(Scholar of Sidney-Sussex College, Cambridge.)

(*Before the Institute of Metals.*)

Synopsis.

This investigation on the copper-tin alloys forms a continuation of the work done by Stockdale on this system. The alloys have been examined both by thermal and micrographic analysis, and the results obtained have confirmed in many respects the classical work of Roberts-Austen and Heycock and Neville.

The $\alpha + \beta$ β boundary has been carefully determined micrographically. This boundary shows a sudden change in direction at 580°, which together with other micrographic evidence favours Stockdale's view of a polymorphic change of the β constituent.

The eutectoid point has been found to be at Sn 16.5 (or 73.15 per cent. Cu by weight), the temperature of the inversion being 520°.

The "transformation" curve has been determined carefully by thermal analysis, and the results are entirely in agreement with those of Roberts-Austen and Stansfield. In particular, the slight horizontal indicated by them at about 610° has been confirmed. As determined by the present author, it exists from Sn 22.5 to Sn 25 at a temperature of 688°. The inclusion of this new horizontal in the diagram makes the interpretation of this region easier, and evidence for a new eutectoid at Sn 23 has been obtained.

CZECHOSLOVAK ASSOCIATION OF CHEMICAL ENGINEERS.

The seventh annual Congress of The Czechoslovak Engineering Society was held at Mladá Boleslav from Thursday, June 23, to Monday, June 27 inclusive. On this occasion the *Czechoslovak Association of Chemical Engineers* also held its annual meeting, in which all chemical engineers assembled as far as they were members of the Czechoslovak Engineering Society.

The Congress was opened on Thursday afternoon by the Plenary Session of Delegates of all sections of the Society in all Czechoslovakia, when the President of the section of Mladá Boleslav (Prof. L. Stekl, [illegible] and the opening of the Technical Exhibition was witnessed.

On Friday there were arranged excursions to some industrial works, including the Skoda Motor Car Factory of Mladá Boleslav, Eger Works (factory of cakes, pastes and ginger-breads, and workshop for figuring silks) at Mladá Boleslav; Carborundum and Electrite Works at Nové Benátky and The Army Camp at Milovice, where a modern battle was demonstrated). In the evening the General Counsellor of Skoda Works, Mr. V. Klement, delivered an address on "Historical Development of the Bohemian Automobilism" (published in the Congress Communications and in Národní Listy for June 26).

On Saturday, in the presence of very many members, the Annual Meeting of the *Czechoslovak Association of Chemical* Engineers was held, the President, Prof. C. K. Krauz, Eng.D., in the chair. After the annual report on the activity of the Association had been read a series of special reports was given as follows:

Prof. C. K. Krauz, Eng.D.: "What is Chemical Engineer?"

K. Eger, Eng.: "Outlook for our Young Technical Generation in Sugar Industry."

O. Turek, Eng.D.: "Poison Gases."

B. Tykač, Eng.: "The Coal Mines and the Chemical Engineer."

Prof. J. Milbauer, Eng.D: "The Present Situation of the Inorganic Industries."

O. Roubínek, Eng.D.: "Transport Establishments in Sugar Factories."

A. Majrich, Eng.D.: "Gas Warfare."

F. Hruška, Eng.D.: "Chemical Engineer in Food Industry."

Prof. J. Šťastný, Eng.: "Motor Fuels."

L. Pick, Eng.D.: "Ether as Motor Fuel."

Besides these personally given reports (which were throughout published in the periodical of the Association, *Chemický Obzor*) there were presented at the Congress many other communications from the branch of Chemical Industry which all are published in the Congress Communications, as following:—

K. Laskot, Eng.: "Power Alcohol."

Prof. J. Šťastný, Eng.: "The Importance of Alcohol Industry in the National Defence."

Gen. F. Kolařík, Eng.: "Army Technical Institute and the Technical Researches."

Prof. C. K. Krauz, Eng.D.: "Organic [illegible]"

A. Majrich ,Eng.D. : " War Gases in the Service of the Country."

O. Turek, Eng.D. : " Gas Warfare and Poison Gases."

R. Kopecky, Eng.D. : " The Question of Primary Materials for the War Industry of Explosives."

F. Hruška, Eng. : " Flour in Czechoslovakia."

H. Cron, Eng. : " The Sugar Factory at Dobrovice."

F. Paulík, Eng. : " The Sugar Factory at *Dolní Cetno.*"

J. Kracik, Eng. : " The Origin and Development of the Industrial Works at Bousov."

K. Eger, Eng. : " The Future of our Engineers."

W. Eger, Eng. : " The Sugar Factory of Mnichovo Hradiste."

Communication of the Sugar Factory at Sadska.

Communication of the Ďepold Czernin Sugar Factory at Dymokury.

K. Holub, Eng. : " The Development of Sugar Industry in the Environs of Libnoves."

Th. Brada, Eng. : " On the Theory of Evaporating."

J. Mach, Eng. : " The Alcohol Industry *in view of Modern Science.*"

V. Schullmann, Eng. : " The Manufacture of Yeast."

J. Polák, Eng. : " The Gem and Glass Industry of North Bohemia."

V. Čtyroky, Eng.D. : " The Glass Industry of Jablonec in North Bohemia."

J. Preller, Sng.D. : " Ceramics in the National Defence."

Prof. J. Cerman, Eng. : " The Textile Industry of North Bohemia."

V. Ježek, Eng.D. : " On New Cellulose Textiles."

K. C. Menzel, Eng. : " Paper Factory at Belá-Bězdez."

V. Just, Eng. : " Carborundum and Electrite."

A. Snízek : " Pharmaceutical Industry in Czechoslovakia."

V. Ptáčnik : " Tile Works at Řepov."

V. Bartoš, Eng. : " Institute of Amelioration of Sugar Beets at Semčice."

R. Dlabal, Eng. : " Dairy-Farm at Cejeticky."

S. Skřivánek : " Agricultural Works at *Drazice.*"

As may be seen, the Chemical Engineers were this year represented on the Congress very numerously. From all, about 600 delegates, there were present more than 100 Chemical Engineers; of 28 lectures given, 10 were of chemical nature; and from 112 reports published in Congress Communications (*Almanach*) there were 31 from the chemical branch.

On Sunday a General Meeting of the Society was held, when Prof. J. Z. Hrásky, Eng.D., delivered an address on " Technical Culture."

On Monday the Congress ended with two *excursions arranged to Cosmanos* Dye-Works at Josefodol and to Poděbrady Spa.

FORTHCOMING EVENTS.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

The next meeting of the Society will be held on Wednesday, October 5, at the Chemical Society's Rooms, Burlington House, Piccadilly, London, W.1., at 8 p.m. The following papers will be read :— "The Oil of *Centrophorus Granulosus,*" by A. Chaston Chapman, F.I.C., F.R.S.; " Investigations into the Analytical Chemistry of Tantalum, Niobium, and their Mineral Associates. IX. The Separation of Titanium from Tantalum and Niobium," by W. R. Schoeller, Ph.D., and E. C. Deering, B.Sc.; " The Determination of Aldose Sugars by Means of Chloramine-T, with Special Reference to the Analysis of Milk Products," by C. L. Hinton, F.I.C., and T. Macara, F.I.C.

Informal Dinner. — Arrangements have been made for Members and their friends to dine together at St. James's Restaurant, 178, Piccadilly (opposite Burlington House), at 6.30 p.m. Tea and coffee will be served in the Library at 10 p.m.

THE ROYAL INSTITUTE OF PUBLIC HEALTH.

Wednesday, October 11, at 4 p.m. (at the Lecture Hall of the Institute, 371, Russell Square, London, W.C.1).—" Sunlight and Childhood," with Lantern slides, by C. W. Saleeby, M.D., F.R.S.Ed. (Chairman of the Sunlight League). The chairman will be Mr. Leonard Hill, M.B., F.R.S.,

Director, Department of Applied Physiology and Hygiene, National Institute for Medical Research.

All men and women interested in medico-sociological problems are cordially invited.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

A general meeting of the Members will be held at the House of the Royal Society of Arts, John Street, Adelphi, London, on Tuesday, October 11, at 5.30 p.m. Light refreshments at 5 p.m.

UNIVERSITY OF LONDON, UNIVERSITY COLLEGE.

Monday and Tuesday, October 3 and 4, 10 a.m. to 1 p.m.—Faculties of Arts (including the Slade School of Fine Art and the Schools of Architecture, Journalism and Librarianship), Laws, Science, Medical Sciences (First Year Students only), and Engineering. Reception of new Students by the Provost, the respective Deans, and in the case of women Students, the Tutor to women Students.

Monday, October 3, at 2.15 to 4 p.m.—Faculty of Medical Sciences. Students other than First Year Students.

Wednesday, October 5.—General work of the College begins. 5 p.m.—Inaugural meeting of First Year Students (School of Geography). 5.45—Students of the Evening Courses in Architectural Design.

Thursday, October 6 at 2.30 p.m.—"Egyptian Architecture." A public introductory lecture by Prof. Sir Flinders Petrie, F.R.S.

Friday, October 7, at 5.30 p.m.—"*Michelet et Angleterre.*" A public lecture in French, by Prof. Jean M. Carré, D-ès-L., of the University of Lyons.

NOTICES OF BOOKS.

Spectroscopy. Being Volume III of *Text Books of Physical Chemistry.* By PROF. E. C. C. BALY, C.B.E., M.Sc., F.R.S. (Grant Professor of Inorganic Chemistry in the University of Liverpool). Pp. VIII + 582, with 60 illustrations. Price 22s. 6d. net. London: Longmans, Green & Co., Ltd., 39, Paternoster Row, E.C.4.

Text books of physical chemistry edited by Sir William Ramsey and Prof. F. G. Donnan are so well known and highly prized by scientists that words in their praise would be superrogatory. In order to deal adequately with Spectroscopy, it has been found necessary to sub-divide the book into four volumes, of which the present is the third, in which are discussed those development in Spectroscopy which are the more immediate result of the Bohr Theory, with all the necessary experimental work. The author confesses "to a humbleness of mind born of the difficulty of adequately recording the remarkable progress of the past fourteen years." This was unnecessary as the present work has been brought completely up-to-date, while selection, where such was deemed necessary, has been exercised with discrimination. The work maintains the high standard set up by the learned editors of the series of text books issued by the well-known firm of Longmans, Green and Company.

UNION OF SOUTH AFRICA.

The Department of Agriculture issues a Report on "The Curing of Bacon and Ham on the Farm," by W. A. K. Moskel, M.Sc. It is a useful pamphlet for the farmer, among whom the art of bacon curing has been going out of fashion since the rise of bacon-curing factories.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

23,552.—Jungmann, K.—Manufacture of solid alcoholic solution of free iodine. September 7th.

23,287.—Prodorite, Ltd.—Acid-proof vessels. September 5th.

23,391.—Robson, S.—Preparation of sulphuric acid, &c. September 5th.

23,308.—Carpmael, A. (I. G. Farbenindustrie Akt.-Ges.).—Process for introducing sulphocyanide groups organic compounds. September 5th.

23,440.—Goodyear Tyre and Rubber Co. Method of preparing dithiazyl disulphide. September 6th.

Specifications Published.

260,544. Newport Co.—Process of preparing 2- (or 3-) chloro-quinizarine.

253,946. Cassella & Co., Ges., L.- Manufacture of solutions containing organic phosphorous and complex gold compounds.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

274,492. Alcohols. - Compagie De Bethune, Bully-les Mines, Pas de Calais, France.

Methyl and other alcohols; catalytic agents, preparation of. Catalysts for the synthesis of alcohols, particularly methyl alcohol, by the interaction of carbon monoxide and hydrogen at elevated temperature and pressure are prepared by depositing soluble salts, such as formates, of metals giving irreducible oxides upon a porous support, such as pumice, asbestos charcoal and activated carbon. Uranium, tungsten, vanadium, zinc, glucinum, chromium and titanium are specified as suitable metals. According to the examples, active carbon is heated to redness, immersed in a solution of zinc formate or of a mixture of zinc and chromium formates, and the solution evaporated to dryness. The yields obtained by the use of these catalysts under certain conditions are contrasted with that obtained by the aid of a dried paste of zinc oxide mounted upon pumice.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

ULIMO.

479,681.—All goods in class 3 which includes chemical substances prepared for use in medicine and pharmacy. — Herbert Ireland, Market Place, Blackburn, Lancashire, September 14th.

GENERAL INDEX TO THE "CHEMICAL NEWS"—VOLS. 1 TO 100.

This large volume contains a detailed Index to the first 100 volumes of the *Chemical News, and will be found of great* value to all interested in Chemical, Engineering, Electrical and General Scientific subjects. It has been compiled with great care, is handsomely bound in red cloth, and has been produced at great expenditure of time, labour and money. Carriage paid, Great Britain, 21/- net; Carriage paid to Foreign Countries and the Colonies, 23/- net.

SALE OF PATENT RIGHTS.

The owners of British Patent No. 215012 relating to the Manufacture of New Sulphurised Compounds of Phenol and their application as mordants and No. 224218, Improvements relating to the Dyeing of Cellulose-Acetate Silk are desirous of entering into negotiations with one or more firms in Great Britain for the purpose of exploiting the above invention either by the sale of the Patent Rights or by *the grant of* a licence or licences to manufacture on royalty.

Enquiries should be addressed to ABEL AND IMRAY, 30, Southampton Buildings, London, W.C.2.

ADVERTISER has for DISPOSAL a Stock of recent English and Foreign PERIODICALS, and some Foreign paper-covered Scientific Books at one-quarter or one-third the published price. List on application.—H. E., c/o *Chemical News.*

APPARATUS WANTED.

WANTED, a Second-hand Fortin's Barometer, cm. and inch scales; also Chemical Balances. — Write, "D," c/o *Chemical News Offices.*

THE CHEMICAL NEWS

VOL. CXXXV. No. 3521.

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SOME ASPECTS OF THE PRESENT-DAY INVESTIGATIONS OF PROTOPHYTA.

PROF F. E. FRITSCH, D.Sc., PH.D.,
President of the Botany Section.

(*British Association for the Advancement of Science.—Leeds, 1927.*)

Since the last meeting of the British Association two well-known figures have disappeared from the ranks of British botanists. Reginald William Phillips, after nearly forty years' service in the furtherance of Welsh University education during which he found little time for original investigation, used the years after his retirement to prosecute vigoronsly the work on marine Algae that had attracted him at the outset of his scientific career. That these promising researches were cut short, so soon after they were begun, is a source of very great regret to his many friends. Moreover, of workers on British marine Algae there are but all too few, and a reduction in their number represents a serious loss to science.

The sudden death of Abercrombie Anstruther Lawson, as a comparatively young man, is a heavy blow to British botany. His exceedingly careful work on the gametophytes and embryos of Gymnosperms will always remain as a model of what such researches should be. Lawson had enjoyed the rather exceptional experience of filling academic posts in three distinct quarters of the world ,namely, in the Leland-Stanford University, California, in the University of Glasgow, and in the University of Sydney. At the last he occupied the Chair of Botany from 1912 till the time of his death, and we know enough of his many activities there to extend our sympathy to our colleagues in Australia at the loss they have sustained by his premature demise.

We have also to deplore the death of two well-known botanical artists—John Nugent Fitch, who worked so long for the *Botanical Magazine*, and Miss Matilda Smith, for many years artist at the Royal Botanic Gardens, Kew.

In practically confining my address to the Algae, and more particularly to the freshwater groups, I need make n oapology, for not only have I been a student of these forms for some twenty-five years, but it appears that the simpler Algae have never before been made the subject of an address to this section. My predecessor in 1925, Prof. Lloyd Williams, it is true, dealt with the many points of interest presented by the Phaeophyceae, but my remarks will refer in the main to forms with a much simpler construction than these. Whatever view we may ultimately take as to the relation of the presentday freshwater Algae to the rest of the Vegetable Kingdom, and I shall have something to say on that point anon, they represent the most elementary types of holophytic plantlife to which we are likely to have access. The probability that such forms will ever be found preserved in the fossil state in sufficent numbers and showing the necessary details of cell-structure to be of any value for comparative morphological study, or for the elucidation of the mode of origin of the multicellular plant, appears at the best to be

remote. A study of freshwater Algae is, therefore, one of fundamental importance, not only because they illustrate various stages in the elaboration of a plant-body and afford some rough picture of the early beginnings of plant-life, but because it is in such unspecialised types that many important physiological problems have found and will find solution. From this point of view the absence of adequate facilities in this country for the direct investigation of these forms on the spot is much to be regretted.

The relation of the different types of construction, that can be distinguished among the lower protophyta, to one another, and to the more elaborate parenchymatous soma usual in land-plants must always remain in part a matter of conjecture. There are, however ,certain definite facts which emerge from a comparative study of the simpler holophyhic organisms and that have an important bearing on these problems. It is with these that I shall more particularly deal in the first place.

PARALLEL EVOLUTION AMONG PROTOPHYTA.

It is now nearly thirty years since the doctrine of the flagellate origin of the Algae became firmly established by the discovery in Sweden of *Chloramoeba* and *Chlorosaccus*. These two simple forms agreed with a number of others, already previously distinguished as Confervales by Borzi and Bohlin, in a series of sharply-defined characteristics, namely, the possession of yellow-green, commonly discoid chloroplasts containing an excess of xanthophyll and devoid of pyrenoids, the storage of the products of photosynthesis in the form of oil, and the possession of a motor apparatus consisting of two very unequal cilia attached at the front end. These and other minor characteristics served to separate out from the extensive group of the Chlorophyceae a small set of Algae which became known by Luther's name, Heterokontae. The large remainder of the Chlorophyceae were renamed Isokontae, a designation based upon the fact that here the motile stages bear equal cilia (commonly 2 or 4) arising from the anterior end. In the Isokontae the chloroplasts are often large and few in number and are commonly provided with pyrenoids; they contain the same four pigments as do those of the higher plants and, as far as we know ,in roughly the same proportions. Most Isokontae, moreover, store their photosynthetic products in the form of starch.

Subsequent to this Blackman and Tansley in 1902 performed a valuable service in issuing a revised classification of the Green Algae in which the two classes, Isokontae and Heterokontae, were clearly distinguished, and the same course was adopted by G. S. West in the "British Freshwater Algae," published in 1904 and by most other contemporary authors. Many of these followed Bohlin in regarding the Oedogoniales as a separate class, the Stephanokontae, whilst the designation Akontae adopted for the Conjugatae by Blackman and Tansley implied, though not quite definitely maintained ,a distinct origin also for this group. This practice has been followed by many subsequent writers, although abandoned by Oltmanns in the most recent edition of his great work. He, however, in common with many other authorities, nevertheless segregates the Conjugatae from the remainder of the Green Algae. There can be no doubt that any separation of these two groups from the bulk of the Isokontae obscures affinities and cannot reasonably be defended, although it is true that both Oedogoniales and Conjugatae have developed along very specialised lines.

It is well to realise that the characteristics separating the Green and Yellow-green Algae, like those distinguishing the other great classes of pigmented Protophyta to be mentioned later, are essentially physiological depending on the colouring matters present in the plastids and the types of metabolism associated with them, as indicated by the nature of the substances stored during photosynthesis. That these diverse classes are also in general characterised by other features ,such as the number and arrangement of the cilia in the motile stages, the chemical nature and structure of the cellular envelopes, and sometimes by special peculiarities of the reproductive cells indicates that the physiological distinctions are fundamental and that they go hand in hand with other characters. In separating the Oedogoniales and Conjugatae from the Isokontae we are, however, carrying out a *tour de force*, since in the pigmentation of their chloroplasts, in the possession of pyrenoids with a "starch-sheath," in the storage of starch, and in the chemical nature of their cell-walls these two groups are altogether Isokontan. Nor do they stand more isolated from the bulk of the Isokontae than do many other recognised members of this class, such as the Coleochaetaceae and Vaucheriaceae. As regards the fringe of cilia of the Oedogoniaceous swarmer, which is supposed to have been a feature of the flagellate ancestry of the

Stephanokontae, cilial numbers other than the usual 2 or 4 are not unknown among the motile Volvocales, a matter to which I shall return later. One peculiarity of the Conjugatae, viz., the absence of all motile stages, is in no way confined to them, being found for instance in a large number of Chlorocaccales, whilst it is not impossible, as Blackman and Tansley first pointed out, to relate the conjugation-process to the sexual fusion found in some species of *Chlamydomonas* (e.g., *C. monadina*) in which the gametes are povided with cell-walls. I think there can be no doubt that Isokontae, Stephanokontae, and Akontae all constitute members of the same phylum, however much they may have diverged from one another, and any attempt to separate them must obscure the essence of the present-day concept of the main lines of algal evolution.

It has been suggested to my by various of my colleagues that, having rejected Stephanokontae and Akontae as separate classes, I should abandon the name Isokontae and revert to the old designation Chlorophyceae for the Green Algae. Under this name, however, there were also originally included the Heterokontae and its use might thus prove misleading. In the following I shall therefore continue to use the designation Isokontae for all true Green Algae.

Already at the end of the last century practically every conceivable type of simple plant-body was known in the Green Algae, ranging from the motile or motionless unicell, through manifold colonial forms, to a more or less highly develped filament. This extremely varied somatic development corresponds to a remarkable range of habitat and goes hand in hand with a great diversity in reproductive processes. There is in fact no other group of simple organisms showing such a wide scope in all these respects. By contrast the Heterokontae, when first distinguished, included only relatively few forms. By degrees, however, many additional members have been discovered, and in the course of this century it has become increasingly apparent that there exists a far-going parallelism between these two classes, Isokontae and Heterokontae, which are so sharply segregated by their metabolism and other features that the vast majority of algal workers have regarded them as quite separate evolutionary lines, in no way related to one another.

Thus, in each class we have a series of motile unicells, *Chlamydomonas* and its many allies in the Isokontae, *Chloramoeba* and *Heterochloris* in the Heterokontae, while the palmelloid type, with large numbers of cells embedded in a mass of mucilage, is represented respectively by the Tetrasporales and *Chlorosaccus*, etc. (Heterocapsales). The motionless, often spherical, unicell—we may speak of it as the chloracoccoid (or protococcoid) type of plant-body—is well represented in both classes, and in part the relevant forms are so similar that, prior to the clear recognition of the Heterokontae, they were classed in the same genus. Thus, many species of *Characiopsis* were first included in the Isokontan genus *Characium*, while the type-species of *Chlorobotrys* was first described as a *Chlorococcum*. The unbranched and branched filamentous habits are met with in both classes, while the coenocytic *Botrydium* is now clearly established as a siphoneous variant of the Heterokontan type analogous to *Protosiphon* among the Isokontae. On detailed scrutiny it is not difficult to find other points of parallel; thus, in both classes there are colonial forms with an analogous dendroid construction (*Chlorodendron*, *Mischococcus*), whilst in each the chlorococcoid type is represented by two series of forms, the one reproducing by zoospores and the other (azoosporic) in which motility is completely suppressed. We are indebted to Pascher for first drawing attention to this striking degree of parallel.

The Heterokontae do not, however, exhibit anything approaching the multiplicity of forms that are seen among the Isokontas, in particular they do not appear to have evolved in the direction of the motile colony which is so well developed in some of the other classes. Also the filamentous members are few, and the siphoneous type is as yet only known to be represented by *Botrydium*. The less vigorous development of the Heterokontae ,which is thus manifest, accords with the fact that only a few of the more specialised members of the class exhibit sexual reproduction and that this has not passed beyond the phase of isogamy. The oogamous Vaucheriaceae, at one time referred by some to the Heterokontae, are now by practically common consent regarded as outlying members of the Siphonales among the Green Algae.

The few ciliated members of Heterokontae, that are at present known, without exception show " flagellate " characteristics; that is to say, they are devoid of a cell-wall, their plasma-membrane (periplast) is more or less rigid, but usually admits of some change of shape, multiplication is effected by longitudinal division, the protoplast readily encysts, and sexual reproduction is

not known to occur. Some of the palmelloid members (e.g. *Chlorosaccus*), possibly all, also show these features. The many motile and palmelloid types among the Isokontae are, on the other hand, for the most part on a higher plane of organisation and reproduction, being true Algae provided with a firm cell-wall and usually exhibiting sexuality. When, however, the parallelism between the two classes is recognised, the distinction between flagellate and algal organisation loses force, and it is realised that the assumption of "algal" characteristics has taken place at an earlier stage in the evolution of the one and at a later stage in that of the other.

These conclusions, however, do not apply only to Isokontae and Heterokontae. It is now clear that, in *all* the classes of pigmented photophyta, an analogous evolutionary sequence has been followed, but that the features associated with what may be called "algal organisation" have appeared, if at all, at different points in the sequence in the diverse classes. It is no longer feasible to separate the Algae from the holophytic Flagellata as distinct groups of Protophyta. There is reason to believe that every series of holophytic Flagellates could potentially have acquired algal characteristics, although on the present evidence some have failed to do so.

These points are well illustrated by a consideration of Pascher's Chrysophyceae which, until relatively recent times, were only known to include a wealth of flagellate types, the Chrysomonadales, whose members on the whole favour pure waters and seem to attain a maximum development in the cold streams and pools of mountainous tracts. They are not, however, without their marine representatives (Coccolithophoridae) and also appear to play a conspicuous part in certain kinds of saltmarsh.

The Chrysomonadales are distinguished by a golden-yellow pigmentation of their plastids due to the presence of various accessory pigments, and by storage of the photosynthetic products in the form of oil and of usually rounded lumps of a highly refractive substance known as leucosin, the chemical composition of which is unknown; endogenously formed silicified cysts with a very distinctive structure are also peculiar to this class. The chromatophores are parietal, relatively large, and generally only one or two in number. In the numerous motile individuals the cilia are always borne at the front end, but three distinct series can be traced throughout the class, one with a single cilium (Chromulinales), another with two equal cilia (Hymenomonadales), and a third with two unequal cilia (Ochromonadales). Each series is represented my motile unicells (e.g., *Chromulina*, *Ochromonas*), by motile colonial types (*Synura*, *Uroglena*, etc.) parallel with the Volvocales among Isokontae, and by an extensive development of sedentary epiphytic forms peculiar to the class and provided with a wide offstanding envelope. The palmelloid type is also well represented, reaching an exceptionally high differentiation in *Hydurus*, whilst the dendroid colony is here realised by the planktonic *Dinobryon*. All of these forms are Flagellates, but within the last dozen years a quite considerable number of algal members of this class have been discovered on the continent, and it is clear that the Chrysomonadales too have progressed in the same direction as Isokontae and Heterokontae, but that here the bulk of the forms have remained flagellate and the minority have become algal.

The latter are represented in the first place by chlorococcoid types like *Chrysosphaera*, whose spherical cells contain two parietal yellowish-brown chromatophores, harbour masses of leucosin, and are invested by a firm cell-wall; they reproduce by division of the protoplast with the formation of two new individuals and by means of zoospores closely resembling a *Chromulina*. There are also a considerable number of filamentous forms, such as the unbranched *Nematochrysis* and the branched *Thallochrysis* reproducing by zoospores resembling an *Ochromonas* and *Chromulina* respectively. Here also, according to the most recent investigations, we must refer Lagerheim's *Phaeothamnion*, whose systematic position was long doubtful. In Hansgirg's *Phaeodermatium*, not uncommon attached to stones in cold streams of Central Europe, we have a discoid type parallel with similar forms in other classes. It is not improbable that each of the three series of motile forms previously mentioned has progressed towards the filamentous stage, although at present only representatives of two of them are known. That the balance in the Chrysophyceae is overweighted on the side of the presumably more primitive flagellate types coincides with the fact that sexuality has as yet been very rarely recorded in members of this class, and is only known to be isogamous. The Chrysophyceae exhibit other special developments in the direction of the

Rhizopoda, which are of great interest, but lack of time renders their consideration impossible. Of the great diversity of Chrysophyceae, now known from many parts of the continent, only relatively few have so far been observed in this country, and there is a wide field for research in this respect.

The Chrysophyceae show that in an otherwise rather homogeneous class the type of cillation may be somewhat variable. Some species of *Ochromonas* are very similar to species of *Chromulina* except for this one feature, and the Chromulinales may well have originated from forms of the *Ochromonas*-type by suppression of the second shorter cilium. Only one cilium has so far been recognised in quite a number of the Heterokontae, and here too a suppression of the second is possible.

(To be continued.)

THE OCCURRENCE OF DVI-MANGANESE IN MANGANESE COMPOUNDS.

By V. Dolejsek and J. Heyrovsky.

In 1925 (1) we reported the occurrence of dvi-manganese (Atomic number 75) as a result of electro-chemical and X-ray evidence; in this communication the original work of I. Tacke, W. Noddack and O. Berg (2) bearing on the discovery of the same element was regarded as not conclusive. Since then I. and W. Noddack and O. Berg published several reports of their discovery (3), and lately even on the isolation of the new element (4). How far this claim is justified cannot be discussed before the German authors publish the measurements of their new roentgen-spectrogram and the wave-lengths of the new optical spectral lines they have repeatedly (3, 4) mentioned, without giving any data. The mere appearance of white sublimates, which they ascribe in one instance to the 43rd element (2), in another to the 75th (3, 4), does not—without spectral evidence—seem conclusive.

Both I and W. Noddack as well as W. Prandtl (5) repeated our experiments on the concentration of dvi-manganese, however, with a negative result; they conclude that our chemical, polarographical and roentgenoscopical evidence is false.

Chemical Part by J. Heyrovsky.

Our critics (6) cited the journal, in which our full results appeared (7), by a wrong name and without giving either volume or page. It is, therefore, not remarkable that they falsely construe and fruitlessly criticise a whole series of facts.

Thus, we did not attribute the first kink in the polarographic curve to eka-manganese, as the Noddacks state, but to cadmium.

We were also aware that zinc and nickel could cause polarographic waves at -1.0 volt as well as the unknown elements. The only sure proof, however, was the X-ray spectrum upon which we relied for the presence of dvi-manganese and not upon its properties darkening of hydroxide, green colour of solution.

W. and I. Noddack further state that they tried the polarographic method and found that in about 20 electrolytic processes reductions or depositions could give rise to a wave at a potential of -1.0 volt at the dropping mercury cathode. This is wrong. From the great number of various salt solutions which were studied polarographically in this respect, only traces of zinc and nickel cause a wave at -1.02 or 1.06 volts respectively in neutral solutions. In acidic solutions the reduction potentials of molybdic and tungstic salts fall within this cathodic potential; these values, however, become more negative like all reduction potential, with decreasing hydrion concentration. Traces of vanadium and chromium—which are often present in our specimens—cause a wave at -0.8 volt on the polarographs. In trying our polarographic method the German authors have evidently worked without the autoregistrating polarographic machine, which gives far more reliable and exact results than the ordinary arrangement, revealing many details on the polarographic curves which specially characterise the deposited metal. In our procedure we use manganese sulphate or potassium permanganate, the samples of which show on the polarographic investigation a distinct wave at -1.0 volt. It often happens that there is no kink in the polarographic curve of the Mn deposition potential. It is possible that our critics used salts containing unusually small amounts of dvi-manganese. During electrolytic enrichment the solutions were tested every few days. When the polarogram showed that the solutions were free from impurity, the precipitate was collected and purified by precipitating the heavy metals with H_2S, first in HCl and then in Na-acetate, whereby most of Pb, Cd, Zn, Ni and Co were removed. The precipitated hydroxides were re-examined polarographically

using about 6 mg. in dilute HCl warmed on a water bath. The chloride in about 15 c.c. was used and gave a wave with a distinct maximum at -1.05 v., in dimensions equivalent to a concentration of 1/2 per cent. Sometimes there are two maxima. X-ray examination showed the $L\alpha_1$, $L\beta_1$, $L\beta_2$ lines of 75 often with clear indications of 43 $K\alpha_1$, α_2.

We therefore conclude that the two waves at 1.06 v. and 1.15v. are most probably the deposition potentials of traces of the elements 75 and 43.

The polarograms often also show a wave at 0.8 v. which is due to chromium and vanadium, but never—after the purification with sulphuretted hydrogen from the acetate solution—a wave at -0.4 v. which would be due to either lead or thallium.

Ultraviolet spark and arc spectrum also did not reveal any Tl, Zn, Hg or W. These are elements whose X-ray lines might be attributed to 75 as our critics have objected. It is noteworthy that our sulphide precipitates in which Zn, Hg, and Tl could occur never gave a trace of 75 on the X-ray plates.

The same polarographic, spectral and X-ray investigation was carried out with precipitates obtained from potassium permanganate by means of barium chloride or nitrate. The wet precipitate showed distinctly the X-ray absorption limit of dvi-manganese (8).

Using the sublimation method—denoted by our critics as futile—J. G. F. Druce has recently (9) obtained a volatile sublimate by evolving Cl_2 from MnO_2 showing traces of dvi-manganese both polarographically and from X-ray analysis. Our critics ignore Druce's paper in *Chemisch Weekblad* (10) as well as Polland's communication mentioned just above.

The failure of the Noddack's and of Prandtl to confirm the presence of 75 in manganese compounds may be due to it being present in very small amount in their starting material or to insufficient care and time in preparing the electrolytic deposits.

It is noteworthy that W. Prandtl (5) considered a specimen prepared by I. and W. Noddack, according to his X-ray analysis to consist of an oxide of iron and manganese — which obviously could not have been prepared by the Noddacks' method of precipitation with H_2S from acid solution, but rather by our method—but on the other side has been estimated by the Noddacks as containing 1 per cent. of Rhenium with about 10 per cent. uranium and niobium. Such discrepancies suggest that one or other side did not work with sufficient care.

Basing on our experimental evidence we believe—contrary to the deductions of the *Noddacks—that dvi-manganese is not* precipitated by H_2S from hydrochloric acid solutions and that it is precipitated from manganate solutions by hydrogen peroxide. Thus it does not possess only properties quite intermediate between W and Os, but also has analogies with Mn. The last reports of I. and W. Noddack, according to which 75 might be accumulated from columbite — a Mn-containing mineral — within the manganese precipitates, would agree with *our above deduction.*

The absence of dvi-manganese in platinum ores (11) accords with our assumption of its geo-chemical connection with manganese.

Finally we may refer to I. and W. Noddack's erroneous prognosis of the strength of per-dvi-manganic acid, which they expect to be weak; in analogy with all the per-acids of the seventh group this also should be strong, possessing the one *strong negative contravalency in* Abegg-Bodländer's scheme.

X-RAY SPECTROSCOPIC PART.

By V. Dolejsek.

The method of our x-ray spectrometric investigations is different from that pursued by O. Berg and I. and W. Noddack, *who strongly over-expose their spectrograms* and rather exaggerate the exactness of line measurements; our aim is to obtain —*after comparatively short exposures* of 20-30 min.—a simple spectrum with few lines, which seems to us more conclusive even if the lines appear feeble.

We therefore used in most cases the plate or film only 5 cms. distant from the crystal, or another apparatus with a normal 13 cms. distance; rarely a 20 cm. apparatus was used, all according to the Siegbahn type.

Never *was the duration of exposure* driven so far that the total tungsten spectrum could appear. This takes place only after the anticathode begins to be covered with tungstic oxide coming from the cathodic glowing spiral; however, long before this can happen the specimen is certainly scattered off from the anticathode. Longer exposures are, therefore, in this case, not only unnecessary but even noxious, since then merely the impurities from the tube expose themselves on the film.

Owing to our precautions the chief tungsten lines $L\alpha_1$, $L\beta_1$, did not appear in most of our spectrograms; this removes the ob-

jections of W. Prandtl (5) as well as I. and W. Noddack and O. Berg (3), that we have mistaken the weak tungsten $L\beta_8$ line for 75 $L\beta_1$.

Another of their suggestions, *viz.*, that the mercury line $L\alpha_1$ might equally stand for our 75 $L\beta_1$ cannot be valid, since we have worked with an entire elimination of mercury in the apparatus and ensured its removal from our specimens by purification with H_2S and spectral analysis. The possibility of mistaking the Tl $L\alpha_1$ for 75 $L\beta_2$, which indeed is not possible to decide by mere X-ray test, we have similarly removed by careful purification with H_2S and subsequent spectral test.

We have also observed in some of the spectrograms of our specimens the lines of eka-manganese (atomic No. 43) in about the same concentration as Noddack and Berg report on their "masurium"; yet—although we used the apparatus with great dispersion and for short wave-lengths—we never succeeded in obtaining a sharp separation of the doublet, 43 $K\alpha_1$, α_2. Some spectrograms of our specimens and one of Druce show the line 671 X.U. (*i.e.* 43 $K\alpha$). We could also measure on some of our films the $K\alpha$-line of eka-manganese in the second order, using a cassiterite crystal, which in this order reflects especially well. One of this spectrograms shows the 43 $K\alpha$ in the second order at 1.200 X.U.

(Abstracted from *Rec. trav. Chim.*, 1927, XLVI, pp. 248-255).

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ON THE SEARCH FOR THE HOMOLOGUES OF MANGANESE.

By W. PRANDTL.

OBSERVATIONS ON THE WORK OF I. AND W. NODDACK.

The chemical procedure of W. and I. Noddack is contradictory and incomprehensible. Under the supposition that the manganese homologues form high valency compounds analogous to manganates, chromates, molybdates and tungstates, they treat the minerals first by alkaline oxidation. From this product the eka-manganates are then supposed to be extracted by water. This alkaline solution is treated with hydrogen peroxide to precipitate the MnO_2 and, acidified, with H_2S to precipitate the sulphides. Should the manganese homologues behave analogously to manganese, they ought to accompany the manganese dioxide, however, the authors found this not to be so. Should the homologues be analogous to chromates, H_2S ought to reduce but not precipitate them in acidic as well as in alkaline solution.

Should they, finally, resemble molybdates and tungstates, H_2S would not precipitate them from alkaline solutions, and only incompletely from acidic ones.

The report of W. and I. Noddack on the behaviour of 75 towards H_2S is contradictory. In general they precipitate rhenium repeatedly with sulphuretted hydrogen from an acidic solution together with other metals as a grey sulphide, which they regard as insoluble in ammonium sulphide. On the other hand, they report that ammonical sulphide does not precipitate their rhenium solution: only after acidification this solution is said to yield a grey precipitate, sparingly soluble in ammonium sulphide. In acidified solution rhenium is reported to give no precipitate with H_2S in the cold, and a slight cloudiness when hot. We have probably to suppose that the eka-manganate solutions are reduced by H_2S and that the new elements are present in the sulphide as cations. However, if this is so, why do they change the new elements in the eka-manganate form? they could precipitate them at least equally well by H_2S from acid solutions after fusion with the hydrosulphate.

W. and I. Noddack probe their method with mere predictions, which they have of eka-manganese; since the authors seem to regard such predictions almost as a criterion of the occurrence of these elements scepticism cannot be further restrained.

In no part of the periodic system it is so difficult to predict anything about missing elements as in the seventh groups in the case of 43 and 75. Mendelejev had good reasons to say nothing about their properties. The seventh group contains a break in the system. Just as it is impossible to derive the properties of the halogens from the homologues of sulphur on one side and those of the inert gases on the other, it is as difficult to predict the properties of the manganese homologues from those of molybdenum—tungsten and ruthenium—osmium respectivelly.

The Noddacks interpolations between 791 m. p. of MoO_3 and 22.5 m. p. of RuO_4, between 1800 m. p. of WO_3 and 55 m. p. of OsO_4, are without meaning.

What significance can be ascribed to the melting points for E_2O_7 350 and D_2O_7, 600 so calculated, when it is remembered that Mn_2O_7 is an explosive gas at ordinary temperature, and also that manganates are so unstable that they do not occur in nature? Of much greater importance would be the chemistry of the lower oxides which compounds should yield coloured cations of which the Noddacks know nothing. Not much better founded are their data on the occurrence of the manganese homologues in the earth's crust.

Further, the Noddacks papers contain still other data which seems to be unfounded. Thus, they give exact percentage compositions of very complicated mixtures obtained as precipitates, the analysis of which, even if possible, could need an extradordinary analytical skill.

They state, *e.g.*, that they obtained .05, .2, .8 or 5% Rhenium in precipitates although there is neither X-ray spectroscopic nor any other way of estimating this element.

OBSERVATIONS ON THE WORK OF O. BERG.

The chief argument of O. Berg against the negative results of Prandtl's examinations of their specimen said to contain .8%—1% Rhenium was that Prandtl was unable to distinguish any Rhenium lines because he did not even find the lines of Nb and U which were said to be present in about 10 times that quantity. First of all too little was available for complete analysis and secondly Berg's own spectrogram of this specimen did not show any uranium line, nor was there the 75 L, line distinguishable.

The great number of spectrograms which Berg considers necessary to give some positive results support Prandtl's statements, *viz.*, firstly, that W. and I. Noddack never knew beforehand if any of their preparations contains Dvi-manganese or not, and secondly that their results are still not reproducible.

(*Abstracted from Zeitscher. Angew. Chemie*, 1927, LX, 621).

ON THE DETECTION OF THE MANGANESE HOMOLOGUES.

By N. SELJAKOW AND M. KORUNSKI.

W. and I. Noddack have criticised Seljakow and Korunski's investigations as they failed to find any indications for manganese homologues in specimens obtained from platinum ores. They explain their negative results by a too small X-ray dispersion (0.06 mm. between CuK_α and $K\alpha_2$) as used by the Russian investigators.

Seljakow and Korunski now show that the number 0.06 mm. refers to the width of the slit and that nowhere in their own communication was the dispersion described; they deduce that their dispersion is even greater than that used by the German investigators. The spectrogram showing the dispersion of Zn K_α and K_{α_2} is given.

(Abstracted from *Physikalische Zeitschrift*, 1927, XXVIII, 478.)

GENERAL NOTES.

AMERICAN CRITICISM OF BRITISH COAL INDUSTRY.

SOME FALLACIOUS OBSERVATION'S

Mr. Philip Gee, Director of the Colliery Owners' Publicity Department, issues the following statement :—

According to cabled reports an American organisation described as the Institute of Economics has been busying itself for several months in investigating the British Coal Industry.

What may be the competence of the investigators it is impossible to say until their names and qualifications are known, nor is it at present apparent what form their investigations took; but it would, perhaps, have been more seemly for them to have confirmed their immediate efforts to setting in order their own coal industry, in which a strike has been raging for several months.

The report appears to make the usual observations about "reorganisation" so dear to the mind of the "economist" who does not have to organise a business enterprise from day to day.

There is, however, one passage in the cabled reports that should be challenged at once. It is stated—as evidence of the

" inefficiency " of British mining practice —that only one-fifth of British coal is cut by machinery as contrasted with two-thirds in the United States. As a matter of fact, according to the annual report of the Secretary of Mines, 53 per cent. of that coal raised in Scotland is machine-cut and 33 per cent. of that in Northumberland, with varying percentages in other districts.

But possibly the investigation of those American economists did not extend to Sir Richard Redmayne's evidence before the Sankey Commission. Dealing with this very point Sir Richard said :—

" It is quite rash and quite wrong to suppose that mechanical coal-cutters can be employed broadcast in all coalfields. They are quite impossible of application in a great number of the Welsh coal mines, and not only in the Welsh coal mines but in a number of other coal mines the United Kingdom because the coal will not stand to be cut. No sooner does the machine proceed to work on the face than the coal falls upon it. You might say you can stay up the coal, but then the machine cannot travel. Again the condition of the roof does not allow of the application.

And in his evidence before the Samuel Commission the same authority said that :—

" Too much must not be made of this comparision (between the quantities of coal machine cut in Britain and the U.S.) for the natural physical conditions in the United States are, on the average, vastly more favourable to machine-mining than in the case of Great Britain."

That is, unfortunately, only too true. Providence has given us most of our coal in narrow seams, whereas the coal in the mines of the United States—true to the American tradition—appears to be located in cliffs. And then, to their natural advantages, they add a working day longer than in Europe. According to the report of the Samuel Commission our nominal eight-hour day gives $6\frac{3}{4}$ hours working time at the coal face, but " in the important coal States, such as Pennsylvannia, Virginia and Illinois, there is no legal limitation of hours. The standard working time is usually given as 8 hours a day for 6 days in the week. This appears usually to mean 8 hours in the actual work-place, *i.e.*, exclusive of time spent in getting to and from the pit mouth. This would make the working time materially longer than in most European countries."

Finally, the Investigators of the Institute of Economics are reported as observing that here is no room for the "several thousand" mines now being operated. Actually 98 per cent. of our output is produced by 715 undertakings, but this accusation of an excessive number of mines is really an example of the " pot calling the kettle black."

To quote Sir Richard Redmayne once more :—

" There appears little doubt that in the United States of America there are opened out a greater number of coal mines than are actually required. It has been stated on good authority in America that if all the coal mines of the United Staes were worked all the year round instead of, on an average, of nine months in the years, there would be provided in that country a surplus of about 200,000,000 tons of coal per annum. From which it is evident that the United States must strive more and more to obtain a larger share of the export trade in coal and that Great Britain can only maintain her present leading position by producing cheap coal and carying it by land and by sea at cheap rates."

And that last sentence may account for the apparent desire of certain persons in the U.S. to decry a very dangerous competitor.

DEATH OF PROFESSOR SVANTE ARRHENIUS.

The death took place on Sunday, October 2, at the age of 68, of Professor Arrhenius, the great Swedish scientist. His fame was international. He came to London in 1914 to receive the Faraday Medal of the Chemical Society, on which occasion Sir William Crookes (founder of the *Chemical News*) said :—" The world is deeply in need of researchers both of the type of those whose genius is characterised by that fertility of resource in experimental investigation exhibited by Faraday and of the type of Arrhenius. Both are revolutionaries and founders of new kingdoms. The world's debt to them is incalculable."

NEW IRISH FREE STATE PATENTS AND TRADE MARKS ACT.

IMPORTANT LEGISLATION.

Messrs. Rayner & Co., the well-known Chancery Lane Patent Agents, call attention to the new situation which is created by the coming into force of the new Patents and Trade Marks Act in the Irish Free State on October 1, 1927.

Previously, British Patents and Trade Marks have covered the whole of Ireland, but, with the new Act in force they will automatically cease to function in the Irish Free State.

It is therefore necessary, for all holders of British Patents and Trade Marks desiring to retain their protection in Southern Ireland to "validate" their patents and trade marks there.

British patents and trade marks will therefore be continued upon the Irish Register if a certificate of the patent or trade mark is lodged in the Free State and renewal fees paid as in England together with other conditions which are required.

Should any of our readers desire more detailed information on this important subject, Messrs. Rayner & Co., 5, Chancery Lane, W.C.2., will be glad to supply it free of charge.

CHAINS AND THEIR USE.

An invaluable booklet has been issued by the Factory Department of the Home Office on "Annealing and Use of Wrought Iron Chains." The information is based on the results of experiments conducted at the National Physical Laboratory. Chain accidents are largely ascribed to brittleness due to skin-hardness and to defects in manufacture, failure to examine chains, and ignorance as to what is a "safe load." This booklet contains essential facts that should be known by all chain users and should be in the hands of both employers and workmen. Its price is only one penny, and employers throughout the country would be well advised to purchase and distribute copies to those whom they employ. It will enable the workman concerned to take an intelligent interest in his work, and if the advice is followed will undoubtedly lead to a diminution of accidents.

BRITISH STANDARD TUNGSTEN FILAMENT ELECTRIC LAMPS.

The British standard specification for tungsten filament electric lamps, No. 161, which was issued in 1924, has been revised chiefly by the addition of four schedules for traction, vacuum train lighting, gasfilled train lighting and gasfilled 'bus lamps. The modifications made are not numerous, the chief one in the general clauses of the specification being the addition of a switching on and off test. The figures in Table II of the schedules for vacuum and in Tables II and III for gasfilled lamps have been slightly modified. The dimensions of the bayonet cap, given in Appendix II, have also been modified to bring them into line with the dimensions recently adopted by the International Electrotechnical Commission.

Copies of this specification, No. 161-1925, can be obtained from the British Engineering Standards Association (Publications Department), 28, Victoria Street, London, S.W.1.

INTERNATIONAL ECONOMIC CONFERENCE CATALOGUE.

A catalogue of all documents published for the International Economic Conference has been published by the League of Nations. All who are interested should ask for this catalogue, which will be sent free of charge on application to Messrs. Constable and Co., Ltd. (who are the authorised agents for the publications of the League of Nations in this country), 10-12, Orange Street, London, W.C.2.

Notices and Proceedings of Societies

THE FARADAY SOCIETY.

The Effect of Temperature on Diffusion Potentials. By E. B. R. PRIDEAUX.

During the course of work which has been designed to examine the relations between diffusion and membrane potentials, there has been occasion from time to time to test the variation of these with temperature over the ordinary range, in the case of alkali salts of some organic acids. No variation has been found which was above the limit of an error which was to be expected in these experiments. This constancy has some practical importance as enabling measurements to be carried out without a thermostat. A review of the ionic mobilities and transport numbers of strong electrolytes has partly confirmed the present thesis; that the temperature coefficients should be low or perhaps quite negligible over a temperature range of about 10°. Since however the existing data are insufficient, it was decided to investigate the problem in the case of a few typical electrolytes at the two standard temperatures, 18° and 25°, using the ideally sharp flowing junction, which removes the uncertainty as to whether a pure or mixed boundary is present.

THEORETICAL.

In the equation—

$$E_0 = \frac{R}{nF} T \times \frac{u_a - u_k}{u_a + u} \log \frac{a_1 c_1}{a_2 c_2},$$

the values of the terms $\frac{u_a - u_k}{u_a + u_k}$ at different

temperature may be determined from the transport numbers or ionic mobilities, and in the first place from those at infinite dilution, if as is the case with most uni- univalent electrolytes the transport numbers do not vary within the limits of concentration taken, *i.e.*, 0.1 N and 0.01 N in the present series.

Since the ionic mobilities become more nearly equal as the temperature rises, u_a or u_k decreases, and tend to compensate for the increase in the factor RT/nF. If this compensation is exact, the temperature coefficient of diffusion potentials will be zero.

Experimental.

In an apparatus somewhat similar to that described by Scatchard, a flowing junction is set up, which is supplied by two reservoirs containing the two solutions, of concentrations c_1 and c_2, having equal hydrostatic pressures at the junction. A few drops of a suitable indicator may be added to c_1 in order to make the boundary visible. The solutions are connected by side tubes with saturated KCl calomel electrodes. The potential differences between these, *i.e.*, the diffusion potentials were measured on a Cambridge portable potentiometer, type B, used with an external galvanometer and scale. The standard of potential was a cadmium cell, checked from time to time against an N.P.L. standard. The flowing junction and reservoirs were immersed in a small thermostat regulated by hand. The potential becomes constant at once if the ujnction has been properly set up, and remains so as long as the solutions are supplied. Individual readings agreed as closely as the scale permitted, *i.e.*, to about 0.2 millivolt.

Solutions were made from water which had been freed from carbonic acid by a current of air free from carbon dioxide. The sodium hydroxide was freshly made from a carbonate-free stock which was kept in a silver bottle. The potassium benzoate was made from the pure acid, neutralised hot in a silica basin with standard potassium hydroxide, and finally adjusted in the presence of phenylphthalein. Potassium phenyl acetate was prepared in a similar manner. Piperidinium hydrochloride was made from a weighed quantity of the pure base, neutralised by standard acid (to methyl red), diluted to the required concentration and checked by titration with silver nitrate. The acetic acid was made from A.R. reagent, and standardised as usual.

Discussion of Results.

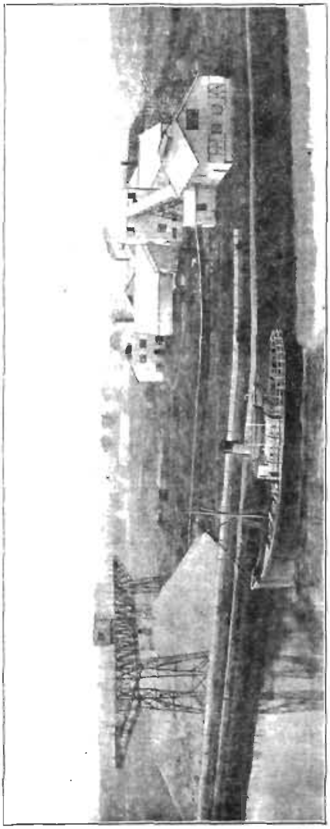
A few cases require special comment.

The diffusion potential of silver nitrate at 25° is due to Cumming. It was measured by him at a static junction, as the difference between the potentials of two Ag, $AgNO_3$, N/10 and N/100, concentration cells (a) without and (b) with, elimination of diffusion potential by a saturated solution of ammonium nitrate. The present value, at 18°, was also determine dat a static junction, but was a direct measurement of the diffusion potential of the $AgNO_3$ concentration chain, the end electrodes being two saturated KCl calomel half-cells which were separated from the silver nitrate by saturated ammonium nitrate. Acetic acid was added as an example of a weak electrolyte, and it was of interest to ascertain whether the Planck theory applies also to this class. It is a favourable case, since the dissociation constant does not change appreciably either with the concentration, or with the temperature within the limits over which these factors were varied. The potentials were found to be as steady as usual, but do not agree as well as usual with the values deduced from the transport numbers and the ionic mobilities, the latter being calculated from the dissociation constant 1.85×10^{-5}. Since the experimental values are lower, this may be due to a special difficulty in producing an ideally sharp junction between different concentrations of a weak electrolyte, only a small proportion of which exists as ions.

The diffusion potentials of the other electrolytes, which had been previously recorded, and obtained at static junctions are in good agreement with the present values, showing that the static junction in these cases may give a sufficiently sharp boundary. Together with the other examples, the diffusion potentials of which had not been previously determined in any manner, the Table includes all the principal types of strong electrolytes—acid, alkali, salts of strong acid and alkali, alkali and weak acid, weak base and strong acid, and a weak acid. The diffusion potentials of all these are are found to have temperature co-efficients which are either zero, or not more than 0.5 of a millivolt (except acetic acid) for 7° within the ordinary temperature range. In the first part of this paper it has been shown that this is a consequence of the relation between temperatures and ionic mobilities.

These results may be embodied in the statement that the diffusion potentials between concentrations of the same strong electrolytes have as class very low temperature coefficients.

Science and Building Material



A Small Portion of the Works, Which Extend to Thirty Acres.

The Housing Question is one of great importance to the whole community, whose comfort and health so largely depend upon healthy homes. We want adequate houses, but we also want houses that are well constructed of the best available material. Science has very largely assisted in providing the most suitable building material and in shewing how the best type of house can be erected.

In the effort to provide adequate housing accommodation for the community, making up the ground lost during the war, builders and local authorities have had to utilise various kinds of material besides brick and stone, such as steel, concrete slabs, etc. Now that the house shortage is not so acute, more attention can be paid to the material employed.

In this connection our attention has been called to the insulating material under the name of " Fosalsil," which, by all accounts, possesses several characteristics not met with in the ordinary building material.

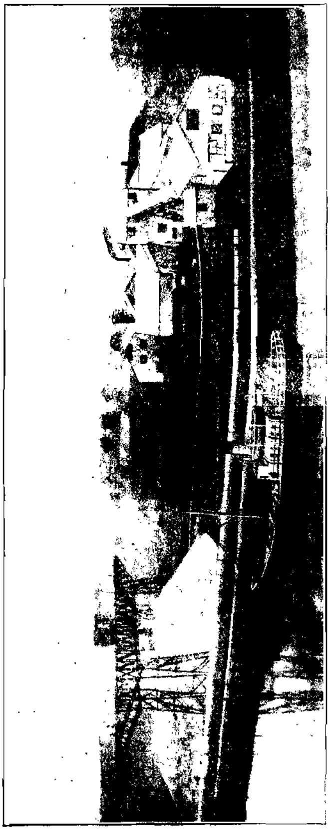
The name " Fosalsil " is composed of Fos (fossil), Al (alumina), and Sil (silica).

Perfect insulation, which saves 60 to 70 per cent. of the heat usually lost in buildings is one of its virtues. Exceptional strength, great fire-resisting qualities are others. " Fosalsil " is a diatomaceous earth, composed apparently of minute silica fossil shells, etc., and an analysis of which, after being fired, reveals the following results :—

Silica	76.5 per cent.
Ferric Oxide ...	8.9 ,, ,,
Alumina	10.1 ,, ,,
Lime	1.1 ,, ,,
Magnesia	1.4 ,, ,,
Soda	.7 ,, ,,
Potash	1.3 ,, ,,

Other laboratory tests shew that a small tin coated with about ¼ in. of " Fosalsil " cement and filled with red-hot coals, can be held in the naked hand, while a strip about 5in. long made of the material can be made red-hot at one end, and can be easily held by the other end in the naked hand. The melting-point was

Science and Building Material



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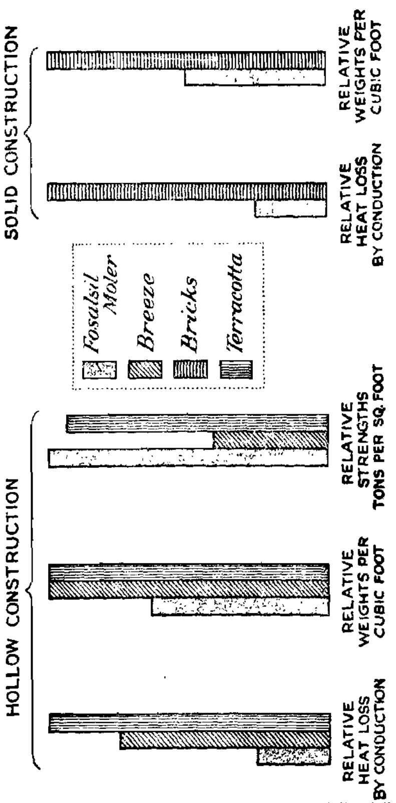
shewn to be 1,280° C., the hollow partition blocks shewed a crushing test of 64.6 tons per square foot, or ½ ton per square inch. One cubic foot of "Fosalsil" solid brick weighs 57 lbs. It has been found that if an ordinary fire brick, an ordinary brick, a concrete slab, and a "Fosalsil" brick be placed close to and an equal distance from a fire for 15 minutes, the last-named will be quite cool, whereas all the others will be too hot to touch with impunity.

Various tests have been carried out at the testing works of Messrs. David Kirkaldy, The National Physical Laboratory, Teddington, London Gas Companies, and all shew the useful characteristics of the material as regards weight, strength, melting point, thermal conductivity, co-efficient of expansion, etc. For instance, a leading London Gas Company shewed that the temperature of an uninsulated wall of retort-setting of ordinary fire-bricks was 195° C., but when insulated with "Fosalsil" (Moler) porous insulating bricks it was reduced to 70° C., a truly remarkable result.

Already the merits of this remarkable material have been recognised, and we have seen a list of over 70 Government buildings, hospitals, hotels, etc., to whom "Fosalsil" bricks, partition blocks, etc., have been supplied. The material is manufactured by Moler Products, Ltd., at Colchester, and in order to meet the increasing demand, new works, 30 acres in extent, have just been opened at Hythe, Colchester, photograph of a small portion of which we give on the opposite page. The works, which will quintuple the output of the original plant, are convenient to the tidal River Colne and the L.N.E. Railway.



The experts who attended the opening were deeply interested in all they saw and loud in their praises of the admirable labour-saving design and equipment.

The block on this page shews the relative heat loss, weight, strength of "Fosalsil" and other building material.

The sole selling agents for "Fosalsil" (Moler) Insurating Bricks, Partition Blocks and Compositions, are the well-known trade distributing firm of Messrs. J. H. Sankey & Son, Ltd., of Essex Wharf, Canning Town, London, E.16. Readers interested may like to know that "Fosalsil" (Moler) Products can be seen and information obtained at the City Offices of Messrs. J. H. Sankey & Son, Ltd., at 7/8, Norfolk Street, Strand, London, W.C.

FORTHCOMING EVENTS.

UNIVERSITY OF LONDON, UNIVERSITY COLLEGE.

(Gower Street, London, W.C.1.)

Monday, October 10, at 1.40 p.m.—Introductory address to Students of all Faculties and Departments, by the Provost.

At 5.p.m.—" The Library of University College." Lecture by the Librarian, Mr. J. A. Wilks, for first year Students of all Faculties.

At 5 p.m.—" A Century of Philosophy at University College." By Prof. G. Dawes Hicks, F.B.A.

At 5 p.m.—" Vision." First of a course of six public lectures, by R. J. Lythgoe (October 10, 17, 19, 24, and 26.)

At 6.30 p.m.—" The Literary and Historical Study of the Bible." Introductory lecture to a course of University extension lectures, by Miss M. S. West, B.D., B.A. (Other lectures, same hour, October 11 and 14.)

Tuesday, October 11, at 3 p.m.—" The Study of Greek Sculpture." Public introductory lecture, by Prof. Ernest A. Gardner. (Illustrated.)

Thursday, October 13 at 5.15 p.m.—" New and Noteworthy Assyrian Texts." Public Lecture by Dr. T. G. Pinches.

Friday, October 14, at 5p.m.—" Hydrogen Ion Concentration." First of a course of three lectures (October 14, 21 and 28). By Dr. Phyllis M. Kerridge.

At 5 p.m.—" Art in the Duchy of Burgundy." By Prof. Tancred Borenius.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

This useful institution, which was founded in 1781, issues an interesting list of meetings which are held at 5.30 o'clock, October 18, November 1, 15 and 29 and *Decemeber 13, of the present year. The list* of meetings up to May 8, 1928, is published.

INSTITUTE OF METALS.
New Session's Programme.

The Council of the Institute of Metals has just issued the 1927-28 programme of the Institute, and of its Local Sections in Birmingham, Glasgow, London, Newcastle-on-Tyne, Sheffield and Swansea. Over thirty papers are enumerated, these cover such practical subjects as brass foundry practice, permanent mould casting in aluminium alloys, special alloys in relation to the corrosion problem, gases in metals with particular problems of the electrical industry. Copies of the programme can be obtained from Mr. G. Shaw Scott, M.Ec., Secretary, 36, Victoria Street, London, S.W.1.

INSTITUTE OF METALS.

Thursday, October 13.—London Local Local Section. " Works Economies " By the Chairman, Mr. A. H. Mundey.

Scottish Local Section.—October 10.—Chairman's address (Mr. S. E. Flock).

Sheffield Local Section.—October 14.—Chairman's address on " Science and Industry " (Mr. J. H. G. Monypenny).

Swansea Local Section.—October 12.—Chairman's address (Capt. L. Tuverner, A.R.S.M., D.I.C.).

OIL AND COLOUR CHEMISTS' ASSOCIATION.

Wednesday, October 12, at 8 p.m., in the Rooms of the Royal Society of Arts, Adelphi.—A discussion on " Colour Standardisation and Testing in the Paint and Colour Industry."

NOTICES OF BOOKS.

Recent Advances in Organic Chemistry. By Alfred W. Stewart, D.Sc. Professor of Chemistry in the University of Belfast. Fifth Edition (Vol. I.). Pp. XIV + 388. Price 21s. net. London : Longmans' Green & Co., Ltd., 39, Paternoster Row, London, E.C.

As noted above, the present is the fifth edition of this work, which is an evidence of its popularity. Hitherto the work has appeared in one volume instead of in two volumes, as on the present occasion. The author explains that as each new edition had to be prepared, fresh matter had to be included in order to keep pace with the evolution of science, and as there was a *limit on the size of the volume*, he was forced to omit an increasing amount of useful and interesting matter from each edition. In order to include the hitherto excluded matter, incorporate new and up-to-date information and make the book more complete, the work has been issued in two volumes. The inclusion of new chapters on Modern Reagents, the Aliphatic Diazene Compounds, the Ketens, Carhohydrates, the Sesquiterpenes, the Applications of Electronics to Organic Chemistry, etc., etc.,

volume arrangement. While Volume I, in a sense, forms an introduction to Volume II, it is also complete in itself, and contains matter suitable for third year students. The second volume can be studied as supplementary to the first volume, but it also can be considered as self-contained, beiug intended for honours students and post-graduate workers. It contains a description of the latest researches in numerous "fields of organic chemistry." Volume I gives an interesting historical summary of organic chemistry and its progress during the latter half of the 19th century. Two chapters deal with Reagents, one with Aliphatic Terpenes. There are in Volume I XVII chapters, and it will in all respects meet the requirements of third year students, as contemplated by the author.

The same lines have in the main been applied to Volume II as Volume I. The historical chapters dealing with organic chemistry from the time of Kekulé will be found handy and useful for reference. The volume is suited for honours students and post-graduate workers, the additions and expansions being written with this object in view. There is a useful table of contents, and a full alphabetical index of subject matter. The author is well known in the scientific world and has established a reputation as a thoughtful writer. The general make-up and binding are in keeping with the high standard of excellence for which Longmans' Green and Company have been justifiably appreciated by scientific readers.

Chemistry and the Home. By HARRISON M. HOWE AND FRANCIS M. TURNER, JUNR. Pp. X +356. Price 7s. 6d. net. London: Charles Scribners & Sons, Beak Street, and at New York.

The authors have written an eminently practical book, in which elementary science is applied to domestic requirements. It might be called a book of recipes, inasmuch as numerous familiar subjects are explained. Adverting to the contents, we cull a few items: Chemistry Everywhere, Chemistry in Foods and Nutrition, Metals and the Kitchen, Glass, with mention of other Ceramics, Science in Cleanliness, Fabrics of Various Kinds, Paper, Ink, Rubber, Photography, Drugs, Medicine, Illumination, Leather, Fuels, Chemistry in the Garden. The work would constitute a very useful addition to the library of any home, to which frequent reference can with advantage be made.

FRENCH TRADE, JANUARY-AUGUST.

A decline of 4,082 million francs, or 12 per cent., is recorded for imports during the first eight months of the current year as compared with the same period of 1926, while exports were lower by 1,862 million francs, or nearly 5 per cent. The trade balance for the eight months was favourable to the extent of 781 million francs, whereas in 1926 there was an unfavourable balance of 2,039 million francs.

SASKATCHEWAN'S PROGRESS.

More agricultural than either of the other "prairie provinces" of Canada, considerable industrial development, however, is taking place in Saskatchewan. Its mineral and power resources, too, are being actively investigated, and although during the past few years the Province has not provided a very extensive market for British goods, some improvement is expected as the wealth of the population increases.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

23,920.—Boehringer, A., and Boehringer Sohn, C. H.—Extraction of theobromine. September 12th.

24,211.—Selden Co.—Catalytically oxidising oxide. September 14th.

24,236.—Selden Co.—Preparation of vanadic acid. September 14th.

24,340.—Soc. Chimique des Usines du Rhone.—Protection of apparatus against acids. September 15th.

24,121.—Zelewski, R. von.—Manufacture of sulphuric acid. September 13th.

Specifications Published.

256,977.—Drukker, M.—Method and apparatus for the demonstration and imitation of chemical reactions.

273,263.—Compagnie de Bethune. — Processes for the preparations of ethylsulphuric acid.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

275,213.—Chemische Fabrik auf Actien, Vorm. E. Schering, 170, Mullerstrasse, Berlin.

Iodo derivatives of cyanophenolethers having the constitution R-O-R'-CN, in which *R* and R' represent iodo-substituted aryl residues, are prepared by condensing iodophenolethers with metallic salts of iodo-oxybenzonitriles or metallic salts of iodophenolethers with iodo-benzonitriles. The iodobenzonitrile or iodo-oxybenzonitrile may be replaced by an iodo-nitrobenzene or iodonitro-oxybenzene, and the condensation product then reduced and treated after diazotization with copper cyanide. The condensation is effected by heating to, say, 210-240° C. in the presence of a catalyst such as copper. The products are useful as intermediates for the manufacture of pharmaceutical preparations. Examples are given of the preparation of 4-(4'-methoxy-3'-iodophenoxy)-3 : 5-diiodo-1-cyanobenzene by condensing 2 : 4-diiodoanisol with the potassium salt of 3 : 5-diiodo-4-oxybenzonitrile and by condensing the potassium salt of *o*-iodomethylether of hydroquinone with 3 : 4 : 5-triiodo-1-benzonitrile.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

ADASPRA.

488,172.—Chemical substances prepared for use in medicine and pharmacy. —Clifford Biddell Price, 5 & 6, Carey Lane, Cheapside, London, E.C.2. September 21st.

PRONTURAL.

483,493.—Chemical substances prepared for use in medicine and pharmacy.—H. R. Napp, Limited, 3 and 4, Clement's Inn ,Kingsway, London, W.C.2. September 21st.

MINERALOGEN.

480,291.—Mineral substance prepared for use in medicine and pharmacy, but not including salves and ointments, and not including any goods of a like kind to any of these excluded goods. — Eugen Solmersitz, 18, Numberger Platz, Berlin, W.50. Germany. September 21st.

MORNING STAR.

482,041.—All goods in class 2 which includes chemical substances used for argicultural, horticultural, veterinary, and sanitary purposes. September 21st.

GENERAL INDEX TO THE "CHEMICAL NEWS"—VOLS. 1 TO 100.

This large volume contains a detailed Index to the first 100 volumes of the *Chemical News*, and will be found of great value to all interested in Chemical, Engineering, Electrical and General Scientific subjects. It has been compiled with great care, is handsomely bound in red cloth, and has been produced at great expenditure of time, labonr and money. Carriage paid, Great Britain, 21/- net; Carriage paid to Foreign Countries and the Colonies, 23/- net.

SALE OF PATENT RIGHTS.

The owners of British Patent No. 215012 relating to the Manufacture of New Sulphurised Compounds of Phenol and their application as mordants and No. 224218, Improvements relating to the Dyeing of Cellulose-Acetate Silk are desirous of entering into negotiations with one or more firms in Great Britain for the purpose of exploiting the above invention either by the sale of the Patent Rights or by the grant of a licence or licences to manufacture on royalty.

Enquiries should be addressed to ABEL AND IMRAY, 30, Southampton Buildings, London, W.C.2.

ADVERTISER has for DISPOSAL a Stock of recent English and Foreign PERIODICALS, and some Foreign paper-covered Scientific Books at one-quarter or one-third the published price. List on application.—H. E., c/o *Chemical News*.

APPARATUS WANTED.

WANTED, a Second-hand Fortin's Barometer, cm. and inch scales; also Chemical Balances. — Write, "D," c/o *Chemical News* **Offices.**

THE CHEMICAL NEWS

VOL. CXXXV. No. 3522.

MERTON HOUSE, SALISBURY SQUARE, LONDON, E.C.4.

TELEPHONES:
Administrative: Central 6521.
Printing Works: Hop 2404.

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SOME ASPECTS OF THE PRESENT-DAY INVESTIGATIONS OF PROTOPHYTA.

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(*Continued from Last Week.*)

Variation in number of cilia is also a feature in the Isokontae, where the dikontan and tetrakontan types are treaceable throughout the class, and quite recently a uniciliate member (*Chloroceras*) has been described by Schiller; this form is particularly interesting because occasional rare individuals show two cilia. Among the Polyblepharidaceae organisms are known with up to eight cilia which presumably result from multiplication. These facts demonstrate the risk of basing a separate class, Stephanokontae, on the occurrence in the Oedogoniales of swarmers with numerous cilia. Moreover, they show that, although cilial characters are of undoubted value in the distinction of the main classes of Algae, the point must not be stretched too far and must be supported by other features.

The parallel development, evident in Isokontae, Heterokontae, and Chrysophyceae, is recognisable, though not quite so markedly ,also in other classes of Protophyta. One further striking instance may be mentioned. The Peridinieae (Dinoflagellata) are a very distinct and rather specialised class of motile forms, abundant in freshwater and marine plankton, though on the whole more strongly represented in the sea. Their most striking characteristic lies in the division of the body of the cell into two usually slightly unequal, apical and antapical, halves by a transverse furrow harbouring one cilium, whilst the other trails out behind into the water. There are usually numerous discoid chromatophores which are commonly dark yellow or brown; a number of special pigments (peridinin, chlorophyllin, etc.) have been extracted from them. The reserves are stored as starch and oil. The nucleus is usually large and conspicuous, and shows either a granular structure or contains numerous fine threads.

It was in 1912 that Klebs described a number of forms that were clearly algal and chlorococcoid members of this class. His *Hypnodinium* shows the derivation clearly; it consists of large motionless spherical cells provided with a firm membrane and possessed of the chromatophores and nuclei characteristic of the class. When reproduction takes place, the protoplast contracts somewhat and develops the distinctive furrows, but this is followed by division without resort to a motile phase. The two daughter-cells show no traces of furrows until a fresh division is initiated. In *Phytodinium* no such furrow-formation is observed ,and with it the last indication of the motile phase has disappeared. It is of interest that, among these chlorococcoid Peridinieae, Klebs distinguished one tetrahedral form (*Tetradinium*) recalling in outward shape the genus *Tetraëdron* among the Isokantae and *Pseudotetraëdron* among the Heterokontae. In 1914 Pascher briefly described a slightly branched filamentous

Alga, Dinothrix, which is stated to have the discoid yellow-brown chromatophores and the large nucleus of the Peridinieae and to reproduce by swarmers resembling a *Gymnodinium*, one of the simplest of the motile types. Unfortunately no further description or figure of this form has so far been forthcoming. There is no doubt, however, that in the peridinieae there have again been diverse " algal developments," although the main differentiation of the class centres around the motile unicell.

As an antithesis to classes like the Chrysophyceae and Dinophyceae (as Pascher has styled the whole series of peridinean forms) we have the Myophyceae (Cyanophyceae), where motile types are altogether nnknown and all the forms exhibit an algal organisation, progressing from the unicellular through the colonial to filamentous types. Even in this very sharply circumscribed class a considerable degree of parallel with those previously considered can be recognised. Other distinct classes of Protophyta chibiting holophytic nutrition, but of more restricted range and generally showing special development in one direction or another, are the bacillariales (Diatoms), the Cryptophycete (including the flagellate Cryptomonadineae and a few little known algal types), the Chloromonadineae, and the Euglenineæ. A detailed consideration of these is unnecessary, but in all of them one or other organism can be recognised as parallel with types in the classes that have been previously discussed, although none has evolved the branched filamentous habit as far as at present known. As instances of parallelism one may cite the occurence of the dendroid colony in the Diatom *Gomphonema* and in *Colacium* among Euglenineae. In the latter class, too, we have the widespread genus *Trachelomonas* in which the motile cell is surrounded by a special rigid envelope separated from the cell proper by a space. This encapsuled type is paralleled in the Isokontae by *Coccomonas* and in the Chrysophyceae by *Chrysococcus*.

To sum up it seems clear that in all the nine classes mentioned evolution has progressed along similar lines and in many cases has led to the production of analogous forms of plant body. Thus, the motile unicellufar individual, the motile colony, the palmelloid type, the dendroid colony, the chlorococcoid type, the simple and the branched filament, the siphoneous type, and others are all to be found in two or more of these classes. In five of them, moreover, the stage of the branched filament has been reached.

While occasional indications of relationship are to be found (e.g., between Heterokontae, Chrysophyceae, and Bacillariales), they are not very marked, and it is probable that all the nine classes represent as many evolutionary series of uncertain origin. We have in them practically all that is left to us of the early evolution of the holophytic organism. It can scarcely be doubted that there were other phyla which have become extinct, nor is it likely that future research will fail to disclose further series than those at present distinguished.

The Relation of the Protophyta to the Higher Plants.

It has been suggested in certain quarters that the simple freshwater Algae are reduced forms which had a more elaborate parenchymatous soma, being in fact " starvation-forms " resulting from a paucity of nutritive salts. It should be stated in the first place that, although reduction-series can be recognised in some groups of the Algae, there is no evidence at all to indicate that freshwater Algae as a whole have undergone reduction. It must be remembered, too, that a large number of similar unspecialised forms are found in the sea. Moreover, with the facts of parallel development before one the supposition of a general reduction becomes practically untenable. We have no knowledge of any forms from which the filamentous Heterokontae or Chrysophyceae, for instance, could be derived by reduction, for the relationshp between Chrysophyceae and Brown Seaweeds formerly entertained is probably fallacious and now no longer credited by most authorities. Until real evidence can be adduced that reduction has occurred, it appears more logical to regard the filamentous forms in the different classes as the end-points of an upgrade development. Further facts that lend support to such an interpretation are the wide distribution of the simpler, less specialised, members of each class (very noticeable in the case of many groups of the Isokontae), while the more highly specialised forms are commonly of more restricted distribution. Within the Isokontae, too, anisogamy or oogamy are associated with the advanced forms and are mainly a feature of the specialised filamentous types, a fact which supports the idea of a progression, rather than of a retrogression. In other classes also sexuality is usually found only in those forms which have the more elaborate organisation.

Amongst the numerous septate filament-

ous Isokontae, it is possible to distinguish four separate series, of which the Oedogonales and Conjugatae have already been recognised as specialised along directions of their own. Of the other two, the Ulotrichales are the simpler and the Chaetophorales the more complex, both possibly originating from a common stock. Many authorities, in fact, fail to distinguish these two groups, but the organisation of the Chaetophorales is so distinct from that of the Ultrichales that, from the standpoint of comparative morphology, their separation is desirable. Whereas in the Ulotrichales we have a simple or branched filament attached by a more or less elaborate basal cell, the central types among Chaetophorales are distnguished by the possession of a plant-body showing differentiation into a prostrate system of creeping threads serving *inter alia* for attachment to the substratum and a projecting system which is more or less richly branched. This differentiation is seen for instance in many species of *Stigeoclonium*, *Colechaete* ,and *Trentepohlia*, representing three distinct families and three distinct developmental lines within this group. Among its numerous members there is much variation in the relative differentiation of the creeping and projecting systems, and reduction of the latter has led to a whole series of specialised prostrate or discoid types (*Aphanochaete*, *Protoderma*, etc.). It is to be noted, too, that the Chaetophorales exhibit a greater morphological diversity and a capacity for existence under more varied circumstances than any other group of Isokontae, and in the Trentepohliaceae include one of the most vigorous and highly differentiated families of terrestrial Algae.

The type of construction just considered is not encountered in any of the other nine classes of Protophyta previous mentioned, although hinted at in the Chrysophyceae and some Myxophyceae. An analogous differentiation of the filamentous thallus into a creeping and a projecting system is, however, characteristic of many Ectocarpale (e.g. *Ectocarpus*) and Nemalionales (e.g. *Chantransia*), which include the simplest the known members of the Phasophyceae and Rhodophyceae respectively. In fact it appears that this kind of plant-body represents a definite stage in the evolution of various classes of Protophyta, affording another instance of parallelism. But, whereas in the Isokontae it represents the most advanced type of which we have any knowledge, in the two great marine groups it is seen in the simplest of the present-day forms, since no unicellular or palmelloid members of these classes are certainly known to exist. A consideration of the metabolism and reproductive features of the two groups of Seaweeds, however, clearly supports an origin for each of them distinct from that of any of the classes previously mentioned.

It will be familiar that, of all the holophytic Protophyta, the two classes Phaeophyceae and Rhodophyceae, which are almost confined to the sea, have alone attained to a high degree of morphological and anatomical specialisation, often affordin one featnre or another marked instances of parallel with those groups of the Vegetable Kingdom which are now dominant on the land. We owe to Church a clear statement of these points of parallel and a suggestion that many, if not all, the fundamental features of higher land-plants were already realised in a marine environment before a terrestrial flora was evolved. The totally differing metabolism obviously renders impossible, however, any direct derivation of the land-flora from forms belonging to either class of marine Algae.

It will be generally agreed that we must seek the origin of terrestrial plants in organisms possessing the same plastid-pigments and the same essential metabolism as they do. The only representatives of such forms among Protophyta at the present day are afforded by the numerous Green Algae, the Isokontae. These however, as has previously been pointed out, stop short at a level of morphological differentiation of the thallus, at which the two marine groups commence. Roughly speaking, too, the stature of the most highly differentiated Isokkontae is approximately equivalent to that of the simpler Brown and Red Algae. Yet, in sexual differentiation and specialisation of the reproductive machinery, there is little to choose between these three classes, although the Red Algae have in part developed post-fertilisation complexities peculiar to themselves.

We are thus confronted with the situation that in the Isokontae we have a class of great morphological diversity in which almost every cocneivable type of simple plant-body has been realised and is still existent at the present day, but which stops short at a massive parenchymatous construction and forms of large stature. In the Brown and Red Algae, on the other hand, where no simple forms of plant-body are certainly known, plants of large size and possessed of a highly developed parenchymatous soma are abundantly repre-

sented. It appears improbable that a class like the Isokontae, showing such extreme capacity for morphological elaboration in every direction and for adaptation to very diverse habitats, should have failed to develop further in the direction generally indicated by Phaeophyceae and Rhodophyceae. Moreover, it must be remembered that they possess the photosynthetic equipment which has evidently proved to be the only successful one on the land, and that practically every group and family of Isokontae has its terrestrial representatives.

What then, it may be asked, has become of the more highly elaborated members of this class? It seems to me that there is every reason to suppose that, approximately at the level of morphological differentiation and stature reached by the Isokontae of the present day, the terrestrial habit was adopted in the remote past, that the more highly elaborated Green Alga became a land-plant, the early forms of which are perhaps yet to be disclosed by palaeontological research. The facts of relative development of the three large algal classes just considered appear to indicate that the first land-plants were probably forms of small stature, although not necessarily quite as simple as the most advanced Isokontae known to us at the present day. In this connection it is not without significance that the oogamous members of this class for the most part occupy a peculiarly isolated position, appearing as outliers well in advance of the rest, although for none of them is there to my thinking any possible connection with the higher land-plants. On the little available evidence it seems possible that oogamy may have been undeveloped or in an incipient stage in the first land-plants.

If one recognises among Phaeophyceae and Rhodophyceae many features of anatomy, life-history, etc., that recall the characteristics of land-plants, I can see in that only a confirmation of the belief that environment has little to do with the broad evolution of the plant-organism and that these features are a natural outcome of the evolutionary trend in the Vegetable Kingdom and not any positive evidence for the view that they must necessarily have originated in a marine environment. The comparative study of the simpler forms of plant-body in the different classes of Protophyta lends great support to such a concept of a general evolutionary trend. Before we adopt the idea of a mythical group of Thalassiophyta as ancestral to the land-flora, the blind termination of the Isokontae must be accounted for. A more intensive investigation of the Chaetophorales, and in particular of the terrestrial Trentepohliacae, than has hitherto been undertaken may well afford data bearing upon the relation of the Isokontæ to higher plants.

It is scarcely possible to touch on the problem of the origin of the latter without some reference to that striking universal phenomenon in the life-history of the land-plant, the two alternating generations. It is just in this respect that the Isokontae are too incompletely known to afford any good points of contact. We know now, thanks to Dr. Knight's researches on *Pylaiella*, that an homologous alternation exists in this simple filamentous Brown Alga, and it is possible that analogous cases are yet to be discovered in the Chaetophorales among Isokontae. In this connection attention may be drawn to certain observations made by Meyer on *Trentepohlia umbrina* which appear to indicate a segregation of sporangie and gametangie on distinct individuals, and other like cases are suspected. These merit a fuller investigation. As a matter of fact, except in a few special instances, the cytological features of the life-cycles of the filamentous Green Algæ are practically unknown, and a reinvestigation of *Coleochaete* (and especially of other species than *C. scrutata*) from this point of view is advisable. Lambert in 1910 reaffirmed the presence in the life-cycle of *Coleochaete* of a succession of small plants that are purely asexual, a feature already emphasised by Pringsheim.

Klebs' classical investigations on the conditions of reproduction in various Algae have generally been regarded as disposing of the possibility of any alternation between asexual and sexual filaments such as Pringsheim postulated, but on closer consideration they afford no absolute proof of its non-existence. In the usual dense tangle of filaments asexual and sexual individuals may easily be intermingled, either remaining purely vegetative until conditions suitable for the formation of reproductive cells are realised. But there are more important considerations than these. With reference to *Ulothrix zonata* Klebs especially remarks that it always depended on chance whether he was able to get threads to form gametes or not. He also records how at one and the same time threads from one habitat readily formed gametes, whilst those from another failed to do so.. And *Ulothrix* is the only member of Ulotrichales and Chaetophorales

in which Klebs deals at all fully with the sexual reproductive process. Yet from this one case conclusions have been drawn for the whole group!

There is, as far as I can see, little positive evidence that asexual and sexual reproduction takes place at all frequently in one and the same filament of these forms, although there is no reason why sexual individuals should not reproduce themselves asexually after the manner of *Pylaiella*. An important matter for investigation is: are there in these filamentous Green Algae threads that can only reproduce asexually and that by no manner of means can be brought to sexual reproduction? This may be more readily established than possible cytological differences, which call for a highly skilled investigator owing to the small size of the nuclei in most of these forms. The fact that in so many Ulotrichales and Chaetophorales the zoospores have four, and the gametes two cilia, is perhaps significant from this point of view.

Even if, however, further investigation should altogether support the present view that there is no alternation between asexual and sexual filaments in the Green Algae, the example afforded by *Pylaiella* serves to show how easily alternation can arise in lowly filamentous types, and in the case of terrestrial plants it may have originated after, rather than before, the adoption of the land-habit. I have elsewhere indicated how the dual development of the plant-body in types like the Chaetophorales might readily, in the course of further evolution, afford an upright sporophyte and a prostrate gametophyte. I have nothing to add to this and I do not propose to pursue the topic further.

The Investigation of Freshwater Algae.

The many new freshwater Algae that have become known in the present century and that have contributed so largely to the foundation of the concept of a parallel evolution in the different classes, show how much a study of these forms may still be hoped to reveal. And at present the field of research is restricted to quite a small area of the surface of the globe. Over great parts of the earth the investigation of these forms is only just commencing, and enormous tracts are still altogether unexplored from this point of view, so that it is impossible to say what is yet to come to light. Already in many families of Isokontae it would seem that almost every conceivable variant of the central type has been evolved, and there can be little doubt that the parallelism with which I have dealt in the earlier part of this address will become still more striking, as investigation proceeds and some of the present gaps become filled up. I propose therefore to devote the little remaining time to a few words upon the methods of algal investigation.

The position of England as the centre of a huge empire is responsible for the fact that its few algal workers are inundated with demands for the working out of collections made in its dominions and colonies. G. S. West and his father devoted much time to such work which is very laborious, and I myself have fallen a victim to it. It cannot, however, be sufficiently emphasised that Algae are far better examined in the fresh condition, for however well preserved, in these simple forms where details of cell-structure are all important, much is obscured or becomes unintelligible. It is greatly to be desired that competent botanists should take up freshwater algal investigation in different parts of the empire, and the activities of a number of Indian workers in this direction is a matter for congratulation. The necessary literature is now available in a fairly condensed form, and willing assistance will always be furnished by those in this country.

Moreover, an Alga cannot be said to be properly known until it has been studied at frequent intervals and, if widely distributed, examined in its diverse habitats. In this respect almost everything still remains to be done, even in our own parts of the world. Our cognisance of algal genera and species is stil lvery limited, because they have been mainly studied on the basis of casual collections. True, in many cases (as for example in Oedogoniales and Conjugatae) there are such decided reproductive or vegetative characteristics that species can be broadly distinguished without a full knowledge of their complete range; types with the same essential characteristics at least recur frequently in different habitats and in different parts of the world. But there are many groups and genera, where no such decided characteristics exist, or where possibly they still remain to be discovered, and where every algal worker has again and again experienced the difficulty of a satisfactory determination; this is true, for example, of the majority of the Ulotrichales and Chaetophorales, not to speak of the many difficult genera of Chlorococcales and Myxophyceae. In all such cases we shall never arrive at a satisfactory solution of the problem until a

careful study has been made of the range of variation of at least the commoner forms, not only in the course of their annual cycle but in different habitats. The former is in a sense more important than the latter, since habitat-forms may be expected to represent distinct entities that in their respective environments will often maintain constant differences. Brand's study of the *Cladophoras* has, however, shown how much an algal species can vary in the different seasons of the year, and analogous studies of species of genera like *Ulothrix*, *Stigeoclonium*, *Trentepohlia*, etc., are urgently required. They will not only lead to some solution of the "species" difficulty, but may as already indicated afford valuable data in connection with possible points of contact with higher plants. Moreover, they are readily compassed during periodicity studies, such as have already afforded much information as to the conditions determining appearance, abundance, and reproduction of diverse Algae.

(To be Concluded Next Week.)

THE EFFECT OF MANURING A CROP ON THE VEGETATIVE AND REPRODUCTIVE CAPACITY OF THE SEED.

By Viswa Nath, F.I.C., *Offg. Government Agricultural Chemist, Coimbatore*, and M. Suryanarayana, B.Sc., *Assistant to Government Agricultural Chemist, Coimbatore.*

[Note.—The authors have dealt exhaustively with this interesting subject and we have pleasure in giving an abstract and the summary of experimental results and conclusion. The full results are given in the Memoirs of the Department of Agriculture in India ,extending to 120 pp.—Ed, C. N.]

Introductory.

It is a matter of common knowledge that a crop is manured with a view to obtain increased yields and that manuring with cattle manure is preferable to any other form of manuring, especially to manuring with mineral manure alone.

It is, however, not generally known that manuring a crop and the nature of the manure have any influence on the resulting seed in regard to its capacity in the nutrition of its own seedling. The results of experiments described here throw light on this aspect of manuring.

They show :—

1. That a manured crop gives a seed with much better cropping value than a crop that has not been manured.
2. That the seed from a crop manured with farm yard manure is superior to the seed obtained from a crop receiving mineral manure.

The investigation originated from an accidental observation by one of us (B. V. N.)in September, 1921, while testing the malting capacities of dierent samples of *cholam* (*Andropogon Sorphum*) and *ragi* (*Eleuisne coracana*). These samples had to be tested for their diastatic value, 72 hours after being spread out in moist sand in pots. But as accident would have it, they could not be seen for about a month, during which time the laboratory boy was watering the young seedlings. The striking differences in the growth of two sets of plants were traced to the fact that they came from the seed raised from cattle manure and no manure plots of the Permanent Manurials. This observation ,however interesting, had to lie over for the time being.

Meanwhile Lieut.-Colonel R. McCarrison, I.M.S., in the course of his experimental determination of the nutritive and vitamin values of rices in common use in India, suspected that these values might possibly vary with soil conditions. At the suggestion of Dr. R. V. Norris, then Agricultural Chemist to the Madras Government, *ragi* grown on the Central Farm, Coimbatore, was tested and it was found that the nutritive and vitamin values of this grain varied with the manurial treatment of the soil.

This finding gave a further stimulus to the investigation on plant nutrition.

The material used in these experiments was obtained from the Permanent Manurial Plots at the Agricultural College and Research Institute, Coimbatore. These plots were laid out in September, 1909, by the then Agricultural Chemist, Dr. W. H. Harrison. A detailed account of these plots and the results of intensive cropping during 18 years is given by Dr. R. V. Norris.

The plots are ten in number. Seven of these receive artificial manure, *i.e.*, nitrogen, phosphoric acid, and potash alone or in combination ,while two plots have been treated with cattle manure and one is not manured at all.

Summary of Experimental Results and Conclusion.

The experimental evidence so far considered may now be summarised :—

1. The effect of manuring a crop persisted in the seed and was visible in the next crop when the seed was sown in a soil of moderate fertility.

2. A manured crop gave a seed with a better cropping value than an unmanured crop.

3. A crop manured with cattle manure gave a seed with a better cropping value than that from a crop manured with mineral manure or not manured at all.

4. A crop manured with mineral manure gave a seed with a better cropping value than that from an unmanured crop. But the superiority of "Mineral manure seed" over "No manure seed" varied with the nature of the crop.

5. The results of animal nutrition experiments by Lieut.-Col. R. McCarrison with the same grains as those used in plant experiments show that the "Cattle manure seed" was more nutritious than "No manure seed" or "Mineral manure seed."

6. *The grain from a crop manured with mineral manure possessed better nutritive value than the grain from an unmanured crop. As in the case of experiments with plants the superiority of "Mineral manure seed" over "No manure seed" varied with the nature of the crop.*

7. *Fermented farmyard manure was found to possess better manurial value than fresh farmyard manure.*

8. Synthetic farmyard manure prepared by fermenting grass and stubble had as good a manurial value as fermented natural farmyard manure.

9. The water and alcoholic extracts of fermented farmyard manure and the residue were found to have almost equal manurial value.

10. The water extract of fresh farmyard manure was superior in its manurial value to the residue, but the manurial value of the water extract of fresh farmyard manure was distinctly inferior to the water extract from fermented farmyard manure.

11. A small quantity of yeast stimulated a crop and in comparison with fermented farmyard manure gave nearly one a half times the yield.

12. A minute amount of yeast stimulated to a marked extent the growth of crop even after the nitrogen and phosphoric acid content of the yeast were compensated for by the addition of inorganic nitrogen and phosphoric acid.

13. Evidence and arguments are advanced to show that organic manures besides improving the physical condition of the soil and being sources of ordinary food for plants also supply some agents like "Auximones" or "Vitamins" which contribute greatly to the growth and reproduction of the plant and through the plant and its seed supply more food to animals and plants.

14. Evidence and arguments are advanced to show that in addition to their bio-chemical activity the *micro-biological population of the soil contribute directly to the plant some stimulant which is ultimately passed on to the animal.*

The similarity in the results of plant and animal experiments would point to the direction that Bottomley's "Auximones" for plants and "Vitamins" for animals are probably the same, or if different, exist together and are interdependent, functioning in different ways according to the organism in which they are introduced and the conditions under which they operate.

The results are of great interest and importance and if confirmed generally in other places would be of far reaching value. The mutual support and corroboration that exists between the independently conducted experiments with plants and animals lend strong support to the view that manuring alters the character of the seed. It may be that in the instances considered the results were of an accentuated character as the seed experimented with came from plots that had been under intensive cultivation for a number of years and where the differential manurial effect was of an emphasised nature.

It may also be that in a soil with a good supply of organic matter or with silt brought down by rivers flowing through forest areas, the disparity in the cropping capacity and the nutritive value of the seed from differently manured crops may not be as evident as in the present instance or may entirely disappear.

Nevertheless, the results direct pointed attention to certain fundamental aspects of the problem of manuring and plant nutrition.

Apart from their scientific interest, the findings of the investigators are of immediate practical value to South Indian Agriculture.

It is clearly shown that a crop should be manured—

firstly—to obtained increased yields;

secondly—to obtain a seed with a good

cropping capacity in its next generation, and

thirdly—to obtain a crop with high nutritive value.

The importance of organic manures is emphasised and the lines of future manurial programme are clearly shown.

For purposes of manuring a crop, artificials alone are inadequate. The best results all round are obtained by a pudicious combination of organic and artificial manures.

It is further shown that manuring is one of the ways by which crop improvement can be effected, or the quality of a strain may be prevented from rapid deterioration.

The experimental evidence emphasises the importance of organic manures to South Indian soils which are very deficient in organic matter and indicate in no unmistakable terms the manurial policy to be followed in the future. A basal dressing of a bulky organic manure, supplemented where necessary by artificial manures or a judicious combination of both in which the organic manure preponderates seems to be the best system of manuring.

The inadequacy of the available farmyard manure and other organic manures to meet the needs of the arable area is well known, This being so, the situation calls for immediate action in husbanding our resources of organic manures by :—

(1) the prohibition or restriction of export of oil seeds, cakes and bones,

(2) the utilisation of all waste organic materials for manurial purposes,

(3) the utilisation of sewage by the activated sludge process.

(4) The utilisation of night soil by poudrette manufacture or trenching.

We have great pleasure in giving the results of this important investigation in the *Chemical News* and wish to congratulate the authors on the complete nature of their work, which ought to prove of great value, directly to agriculturists, and indirectly to the whole community. Incidentally, it might be mentioned that all evidence shews that proper cultivation and adequate manuring always increases the productiveness of the soil. It is stated that Russia where both cultivation and manuring are neglected, produces 5 to 7 bushels of wheat per acre, as compared with the Netherlands and Denmark, where intensive cultivation is practised, with about 47 bushels per acre.

THE CARBON ATOM MODEL AND THE STRUCTURE OF DIAMOND.

By R. B. Lindsay.

Abstract from the *Physical Review*, U.S.A.

Electron orbits in the neutral carbon atom.—The atomic model of carbon used is assumed to have four 2_1 orbits. The dimensions of these orbits are computed by a method outlined in a previous paper using various assumptions as to screening, *viz.* : (a) spherical distribution of charge about the nucleus; (b) orientation in orbital planes with randon phase relations; (c) orientation in orbital planes with definitely assigned phase relations. All the methods yeld a value of the aphelion distance in the close vicinity of $2.00a_0$, where a_0 = .532A, agreeing well with the " radius " as obtained from the atomic volume ,i.e., $2.06a_0$. The orbital energies, however, vary from $0.36\ e^2/a_0$ to $0.76\ e^2/a_0$ according to the screening assumption used, the largest value being obtained under hypothesis (c).

Approximate calculation of the lattice energy of diamond.—The atom models as computed under assumption (c) are distributed in the diamond lattice, and the field on any electron due to the rest of its own atom and to neighbouring atoms is calculated as a function of the distance from the nucleus assuming that : (1) the orbital plane of the electron is oriented in a certain symmetrical way relative to the lines joining its nucleus to those of the neighbouring atoms; (2) for a first approximation only the four nearest atoms need be considered as effective; (3) the effect of the electrons in the neighbouring atoms is that of a time distribution of their charges in their orbital planes, disregarding refinite phase relations such as have been assumed by previous writers. An approximate expression for the increase in energy of the electron due to the neighbouring atoms is developed, and the calculation of the lattice energy per electron for various values of a, the lattice constant, is carried out. It is found that a has an upper limit of $3.00a_0$. In particular the lattice energy for $a = 2.74a_0$ comes out to be 0.55 *Rh*, and the corresponding heat of sublimation is 171 k. cal, per mol. The experimental value for a is $2.90a_0$ and for the heat of sublimation from 168 to 177 k. cal. per mol. The limitations of the method employed are emphasised.

THE SOCIETY OF CHEMICAL INDUSTRY'S ANNUAL MEETING AT EDINBURGH.

The following papers were communicated :—

Intermediary Carbohydrate Metabolism. By C. G. LAMBIE, M.C., M.D.

Much light has been shed upon the problem of intermediary metabolism by a study of what happens in diabetes. In this disease, which is due to a lack of the hormone insulin, there occurs a far-reaching disturbance of metabolism, affecting all three great classes of foodstuffs—carbohydrates, fats, and proteins. In the case of carbohydrates, there is an inability to oxidise dextrose and to synthesise glycogen while the fall in organic blood phosphate which normally follows the ingestion of carbohydrate is absent. The fats become more rapidly catabolised as they do when, from any cause, insufficient carbohydrate is being oxidised in the organism. The glycerol fraction of fat is ultimately converted into dextrose, while the fatty acids fail to undergo the final stages of their oxidation sufficiently rapidly, so that β-hydroxybutyric acid and other products of incomplete fat combustion accumulate in the tissues and cause acidosis. The proteins, likewise, undergo more rapid catabolism, some of their amino-acids forming dextrose, others acetoacetic and β-hydroxybutyric acids.

Any explanation of the way in which insulin acts must, however, account not merely for the increased oxidation of dextrose, but for glycogen formation and the changes which occur in protein and fat metabolism. A step towards a solution of the problem would be made by finding among the possible decomposition products of dextrose some substance which not only could be more rapidly oxidised than dextrose but could form glycogen more readily and be capable of entering into equilibrium with the intermediaries of fat and protein metabolism at some point where their metabolic paths meet. The substance in question should also be at least as efficient as dextrose in inhibiting the excessive catabolism and inadequate oxidation of fatty acids, and (by way of accounting for the disappearance of inorganic phosphate from the blood under insulin) it may be supposed either to be itself an ester of phosphoric acid or to form such an ester more readily than dextrose. If it could be shown that these properties were exhibited in the diabetic under circumstances in which they were not exhibited by dextrose itself, the claim of such a substance to be among the proximate intermediaries of dextrose catabolism would be strengthened. Such a substance might also be expected to be capable of causing recovery from insulin hypoglycæmia, just as dextrose does, and to give rise to various products of metabolism similar to those yielded by dextrose. There would also be limits to its toxicity. A large number of substances which have been suggested as intermediaries have now been tested with respect to these various criteria, and of these only one, namely dihydroxyacetone, has so far been found which seems to conform to the requirements. Some of the physiological properties of this substance may therefor be briefly considered. When administered by the mouth, it causes a less marked and less prolonged rise in the blood sugar than dextrose. It also causes a much more marked and rapid rise in the respiratory quotient and the oxygen consumption than dextrose, while the fall in organic blood phosphate is correspondingly more marked and rapid. When injected intravenously in the diabetic, the immediate percentage rise in the respiratory quotient and oxygen consumption and the fall in the organic blood phosphate are comparable with those observed in the healthy individual, whereas little, if any, change in respiratory and phosphate metabolism follows the administration of dextrose in the diabetic. It has further been shown that the rise in metabolism after intravenous injection of dihydroxyacetone is immediate, and is at a maximum about the time when the concentration of dihydroxyacetone in the blood is at its height, and that the metabolism falls *pari passu* with the disappearance of dihydroxyacetone from the blood. On the other hand, when dextrose is administered intravenously to a normal individual, the metabolism rises slowly, reaching its maximum in half-an-hour, while in the interval the blood sugar gradually falls. These observations indicate that, whereas dihydroxyacetone can be directly and immediately oxidised, dextrose has gradually to undergo some transformation prior to its oxidation. It is evidently this change which the diabetic has difficulty in effecting. The hypothesis, therefore, suggests itself that the essential action of insulin is to cause the splitting of the dextrose molecule into a substance which, like dihydroxacetone, is capable of ready and immediate oxidation. In the absence of insulin, the reverse change—the conversion of dihydroxyacetone into dextrose— might be expected, and this has been found to occur, for dihydroxyacetone increases the glyco-

suria in diabetics in proportion to the severity of the disease. Dihydroxyacetone has been found to be very efficient in preventing the excessive formation of β-hydroxybutric acid and acetoacetic acid in diabetics, and Rabinowitch has caused recovery from diabetic coma by its use, unaided by insulin. Its efficiency n this respect diminishes, however, in proportion to the severity of the diabetes.

Further properties exhibited by dihydroxyacetone are as follows :—It forms glycogen more readily than dextrose, it causes recovery from insulin hypoglcæmia as rapidly and efficieutly as dextrose, and it is fermented by organsims which also ferment dextrose. The products of metabolism to which it gives rise—*d*-lactic acid, dextrose, glycerol, carbon, dioxide, and water—are substances normally met with in the animal body, and the substance itself is non-toxic.

It was formerly believed that fatty acid was synthesised in the animal body by processes of condensation followed by oxidation, rednction, and dehydration, from pyruvic acid and acetaldehyde. This did not explain, however, why fat can be formed so much more readily from carbohydrate than from protein. Recently Maclean and Hoffert have brought forward evidence that in yeast stearic acid is formed by condensation of three dextrose molecules. Should this hold for the animal body, then if insulin prevents the conversion of dihydroxyacetoue into dextrose, and dihydroxyacetone is intermediary between protein and dextrose, a reason would be furnished for the difficulty of forming fat from protein save indirectly through glycogen.

Fats having an odd number of carbon atoms are foreign to the animal body, but they are broken down by β-oxidation to propionic acid, which yields dextrose quantitatively in the diabetic organism, probably through its conversion into methylglyoxal.

When dextrose is being metabolised there occurs a fall in the inorganic phosphate of the blood, probably owing to the formation of intermediary metabolites containing phosphorus in organic combination, but whether these organic ecters are concerned with glycogen synthesis or with the splitting or oxidation of the dextrose molecule is unknown. Hexosediphosphate, which is formed during alcoholic fermentation, has been supposed to be of physiological importance, especially since the finding by Embden of a similar compound in muscle, although there appears to be some doubt as to whether the muscle compound is really a mono- or di-phosphate. During fermentation, however, the concentration of hexosediphosphate is at its height when the fermentation slackens, so that it is unlikely to be the precursor of substances destined for immediate catabolism. The synthesis of glycogen from hexosedipnosphate presents difficulties from a stereochemical point of view owing to the consideration that hexosediphosphate yields a lævorotatory hexose on hydrolysis, whereas glycogen yields dextrose. Similar objections apply to lævulose as an immediate precursor of glycogen. There appears to be no difference between the glycogen formed from dextrose and that obtained from lævulose, and this would seem to indicate that both dextrose and lævulose form glycogen from a common substance. If we suppose that lævulose being closely related to dihydroxyacetone, is split into the latter, without the aid of insulin, many of the physiological properties of this hexose—notably the fact of its being a better glycogen former than dextrose and more readily oxidised by the diabetic as well as being largely converted into dextrose by the latter—would be explained.

The old controversy as to whether the essential feature of diabetes is an overproduction of sugar in the body or an inadequate combustion and storage of sugar would be happily resolved if the scheme of intermediary metabolism and the hypothesis of insulin action above outlined be correct. Both views would contain part of the truth—the overproduction and deficient oxidation of carbo-hydrate would have a common cause, to wit, the conversion of the readily oxidisable common intermediary of protein, fat, and carbohydrate metabolism—dihydroxyacetone—into dextrose, which is resistant to oxidation.

Notes on the Cleaning of Coal with Special Reference to Pneumatic Separation. By C. W. H. Holmes, M.Met.

From the very earliest times water has been used in the dressing of minerals and in the more humble operation of coal washing. It has, however, been used only as a means to an end, the end in view being a sharp separation of heavy particles from lighter oues. If, then, this end can be attained by some other means, such as air, the necessity for water disappears. Other considerations, such as the possibility of dressing minerals in waterless districts, the cleaning of coal at temperatures below freezing point, and the separation of materials lighter than water encouraged the development of pneumatic as opposed to hydraulic separtion.

The earliest types of pneumatic separator

followed the lines of the hydraulic jig, and operated more or less successfully at low capacity in connection with ore dressing.

At the beginning of the present century a pneumatic separator, working a thin bed on a pervious riffled deck with a continuous current of low-pressure air, was patented by Messrs. Sutton, Steele, and Steele, of Texas. This separator was operated by a head motion very similar to that actuating the well-known Wilfley table; that is to say, means were provided for accelerating the return stroke in order to accentuate the traverse of the heavier particles across the surface of the deck.

In the light of present-day practice the separator at this stage of its development would appear to have been somewhat difficult to operate, very sensitive to variations in the character of the feed or to any overload, and to have required very delicate adjustment in order to obtain a separation.

In order to overcome these difficulties, the inventors erected a barrier along the concentrate side of the deck against which " a banking of concentrates " was obtained by virtue of the action of the head motion upon the heavier particles. This banking bar is as essential to the efficiency of a pneumatic separator as the condensing plant is to the efficiency of a steam turbine. By means of this banking bar it is possible to separate simultaneously two products of considerable purity, whilst the separation is practically independent of reasonable variations in the character and volume of the raw feed, and the capacity of the separator is considerably increased. From this stage the application of the Sutton-Steel pneumatic separator to the cleaning of coal only was discussed.

Some Recent Developments in the Cellulose Industries. By C. J. J. Fox and L. Hall.

Cellulose plays its part in industry largely by virtue of its physical structure and its stability as a chemical compound. The technical applications of cellulose have been ,until recently, almost wholly dependent upon the skill of engineers and craftsmen and the prescience of business men; latterly the chemist has been playing an ever-increasing part, and the future is going to be very largely dependent upon his efforts.

Artificial silk is now produced in enormous and ever-increasing quantities; its applications are probably still in their infancy, and the limits of their future possibilities cannot be foreseen. Its use in combination with other textile materials has necessitated modified methods of weaving, dyeing, finishing, etc., which, in turn, have reacted on some of the related industries. The viscose process dominates this situation by reason of the cheapness of its raw materials and because of certain advantages it has over other kinds of artificial silk. Thus, 8 per cent. caustic soda solution dissolves 80 per cent. of nitrate silk and saponifies acetate silk, whereas it dissolves on 10-20 per cent. of viscose silk; hence viscose silk is much more resistant to finishing processes, and can be woven together with unbleached cotton before the bleaching stage, and then dyed in the piece.

Derivatives of cellulose are being put to new uses every year; practically, the nitrate, xanthate, and acetate are the derivatives mainly concerned. The true ethers have hardly come into industrial processes as yet, on any appreciable scale, owing to their great cost. The problems raised by the industrial applications of these substances are frequently accompanied by special problems of solvents, softeners, and mechanical contrivances. In general terms it may be said that the outstanding defects of the nitrate are its great inflammability and instability towards chemical agents such as alkalis, sulphides, etc., and towards temperatures such as 100° and upwards. The acetate is more difficult and costly to manufacture, it is easily hydrolysed, and not absolutely stable to water. But it is on the whole more stable than the nitrate, more resistant to the action of light, and practically non-inflammable. It has presented some dyeing problems peculiar to itself which have greatly handicapped its use for silk ,but which now seem to have been solved in a satisfactory way. In the early days of its use the acetate was hydrolysed and the free cellulose dyed in the ordinary way, the special merits of the acetate being wholly sacrificed. The first step forward was the discovery that the ω-methylsulphonic acids of aminoazo compounds possess the special property of liberating their colour bases for general absorption into the acetate fibre. Another step forward was the discovery that colloidal solutions in Turkey-red oil, of azo and anthraquinone dyes, containing no sulphonic groups, give clear solutions in water, and are readily absorbed by acetate silk. A large range of colours based on this principle is now available, and the previous methods of dyeing have been entirely abandoned. The dyes known as cellutyl, ionamine, celatine, etc., are dyes of this kind. The xanthate as such is not encountered by the user: its outstandng advantages are the cheapness of

the raw materials and the merits of the reverted cellulose from the textile finisher's point of view; its covering power, lustre, and cross-section are also favourable. If only its strength, particularly wet, is enhanced it will no doubt come to be regarded as the ideal yarn of the textile trades. The copper-ammonium process is now relatively unimportant except in the Willesden canvas trade, in which it does good service.

Attempts have been made to collect and distribute calorific gas from waste cellulose; the hydrogen-ion concentration has to be controlled and the plant installation is necessarily expensive. Langwell considers that there is a specific organism or group of organism that decompose celluloes, and that cellulose is not essentially more resistant to bacterial attack than are starches and sugars. He thinks the products obtained are closely related to the conditions. Thus, with limited aeration, acetic acid may be *the main product, whereas an increase of* aeration favours the prodnction of ethyl alcohol; lignocelluloses are scarcely attacked and sugars, starches, and hemicelluloses behave like cellulose. Woods containing volatile oils and resins are usually resistant and presumably toxic to bacteria, moulds, and fungi, just as they are very frequently to nsects ,teak wood being a notable instance. There appears to be the opportunity of identifying some of these toxic substances and using them as timber preservatives. Deterioration of qaulity in cellulose materials, inappropriately stored, the retting of many fibrous materials, and the formation of coal are, no doubt, related to these general phenomena. Enzymes appear to be without appreciable action on cellulose; ptyalin possibly has a slight hydrating effect, malt extract is apparently without action, and hemicelluloses are attacked in some instances. An aerobic organism isolated from Rothamsted soil decomposes cellulose rapidly with formation of a yellow pigment, fatty acids, and a mucilage resembling pectin at an optimum temperature of 30°; other carbohydrates do not support growth. These facts have been applied to the preparation of an artificial farm-yard manure from garden refuse, to which nitrogenous substances have been added, in the interesting Adco process.

The industrial problems of the present and future are, of course, unlimited in number and in interest; their economic importance appears to be, in some aspects, immediate. What is to be the source from which shall come the raw materials for the ever-increasing demands of the cellulose industries, old and new? Which of the 2,000 fibre plants available shall be selected from which to derive the thoroughbred and crossbred cultivated products of the future? Cotton and jute and hemp have attained their eminence; why not others? Will it be feasible to extend the use of wood cellulose as a substitute for cotton ,and can afforestation meet the increased demand, as well as that of the ravenous newspaper trade, and of course the timber trades? These and other questions are questions of the hour.

A SYNTHESIS OF 4-HDROXY-3-METHOXYSTYRYL N-BUTYL KETONE.

By Hiroshi Nomura and Shunji Tsurumi.
(*Tôhoku Imperial University.*)

Synopsis.

This communication contains an account of the preparation and properties of 4-hydroxy-3-methoxystyryl n-butyl ketone.

Vanillin (15.2 grams) was mixed with 10 grams of methyl n-butyl ketone, 150 grams of alcohol (95 per cent.) and 30 grams of potassium hydroxide solution (1 : 1), and heated on a water-bath for six hours under a reflux condenser. After the removal of most of the alcohol, the residue was diluted with water and extracted with ether in order to remove the unchanged methyl n-butyl ketone. The aqueous residue was carefully acidified with concentrated hydrochloric acid, when an oil was deposited, which was extracted with ether. The ethereal solution was freed from vanillin by shaking it with a dilute solution of sodium bisulphite, washed several times with water and dried over anhydrous sodium sulphate. After evaporating the ether, the residual oil (7.2 grams) was left in a vacuum desiccator over paraffin and calcium chloride, when it solidified to a yellow mass, which, after recrystallising six times from dilute methyl alcohol and drying in the air for three days, melted indefinitely between 66° and 100°. On being left in a vacuum desiccator until the weight was constant, the crystals melted sharply at 39-40° :

0.7210 lost 0.0531 H_2O. H_2O = 7.37.
$C_{14}H_{18}O_3.H_2O$ *requires* H_2O = 7.14 per cent.

The anhydrous substance thus obtained was analysed with the following results :

4.507 mg. gave 11.865 mg. CO_2 and 3.212 mg. H_2O.C = 71.80; H = 7.97.
$C_{14}H_{18}O_3$ requires C = 71.75;
H = 7.75 per cent.

The crystals melting at 66-100°—which were obtained by one of the authors in the condensation of vanillin with methyl n-butyl ketone in the presence of an aqueous solution of sodium hydroxide—were also left in a vacuum desiccator until the weight became constant, when they melted at 39-40° and produced no depression of the melting point by admixture with the specimen obtained by the present method. As compared with the melting points of 4-hydroxy-3-methoxystyryl n-propyl and n-pentyl ketones, 82.5-83.5° and 50-50.5°, that of 4-hydroxy-3-methoxystyryl n-butyl ketone appeared to be too low. It was therefore, reduced with water and sodium amalgam, when the reduction product melted at 47.5-48° and produced no depression of the melting point by admixture with an authentic specimen of 4-hydroxy-3-methoxyphenylethyl n-butyl ketone. From these facts, the identity of the unsaturated ketone with 4-hydroxy-3-methoxystyryl n-butyl ketone was established beyond doubt.

GENERAL NOTES.

INSTITUTE OF METALS.

The commencement of the 1927-28 session of the Institute of Metals coincides with the opening of new offices of the Institute, and of an additional library and reading room at 36, Victoria Street, London ,S.W.1. The latter is pleasantly situated and comfortably furnished, it should prove an attractive meeting place for members when in London. New members, as well as old, will be welcomed by the Institute to take advantage of these increased facilities. In March next the Institute celebrates its twentieth anniversary, and it is expected that by then the membership will have increased to two thousand. There has just been published an interesting little booklet giving an account of objects and work of the Institute. Copies are obtainable from the Secretary of the Institute at the above address.

AIR MINISTER'S TRIBUTE.

Sir Samuel Hoare, referring to Flight-Lieutenant Webster's victory in the Schneider Trophy race, when he attained the phenomenal speed of 284.14 m.p.h., described this British success as providing one more proof of the unsurpassed excellence of British personnel and materials.

A notable contribution both of material and workmanship to this British success was that of Messrs. Vickers Limited, who were responsible for the steel and manufacture of the crankshaft and the connecting rods of the Napier "Lion" engine installed in the Supermarine Napier S.5.

This constitutes the fourth record-breaking achievement during the current year in which Vickers steels have proved their incontestable excellence. It may be recalled that the frame, gears, axles, shafts, etc., of Captain Malcolm Campbell's "Bluebird" car, with which he achieved a speed of 174.883 m.p.h., were made of Vickers steels, as were also all the vital parts of Major Seagrave's 1,000 h.p. car, with which he set up a world's record speed of 203.841 m.p.h. These two achievements were followed by the remarkable performance of the Bentley car which covered 1472.64 miles (61.36 m.p.h.) in 24 hours at Le Mans, thus winning for Great Britain the 24-hour Grand Prix d'Endurance. The crankshaft—the heart of the engine—of this car was of Vickers manufacture.

Sheffield may well be proud that it has once more demonstrated its ability to maintain its unique reputation for the unsurpassed quality of its steels.

LARGE CANADIAN OUTPUT OF SULPHURIC ACID IN 1926.

According to a statement just issued by the Dominion Bureau of Statistics, production of sulphuric acid in Canada in 1926 (by 8 different plants) totalled 108,230 tons, 66 degrees Bé, valued at $1,306,254, as compared with 83,896 tons worth $1,363,618 in 1925. Exports of sulphuric acid from Canada amounted to 28,137 tons worth $320,324 in 1926 as against 19,178 tons worth $250,096 in the previous year; practically all of the acid was shipped to the United States. Imports totalled only 53 tons worth $9,245 in 1926 and 52 tons at $7,821 in 1925.

TWO MILLION DOLLAR PLANTS FOR TORONTO WATERFRONT.

The Canadian Paperboard Company of Montreal has completed the purchase of a large site from the Toronto Harbour Commission at Commissioner Street and Carlaw Avenue on which to erect a large paperboard mill. The company will occupy about nine acres and will pay the Harbour Board about $150,000. The plans call for the erection immediately of a large paper mill to manufacture paperboard, which will cost in the neighbourhood of $1,000,000 and have an initial capacity of 75 tons per day, the intention being to ultimately install a second unit bringing the capacity to 150

tons daily. The principal raw material is waste paper of which Toronto and surrounding territory produce an abundant supply. The company is already operating three mills located respectively at Montreal, Quebec, Frankford and Cambellford, Ontario, which produce 120 tons of paper-board and 20 tons of groundwood pulp per day.

NICKEL SAUCER (ONTARIO) HOLDS $40,000,000 IN LEAD, ZINC, COPPER.

Some forty million dollars worth of lead, zinc and copper are indicated by the development which has so far taken place near Chelmsford, Ontario, according to Dr. W. H. Collins ,Director of the Geological Survey, who in a recent article on " Lead and Zinc in Sudbury District, Ontario," states that the " diamond-drill work continued over nearly two years has disclosed a series of lenticular bodies, said to contain about one and three quarter million tons of ore containing lead, zinc and copper of an estimated value of $23.00 a ton."

NEW GAS PLANT FOR VANCOUVER.

The British Columbia Electric Railway Company, Ltd., has announced plans for the erection of a large gas plant and tank to cost $650,000. The new plant will have a capacity of 3,000,000 subic feet of gas daily and the tank capacity will also be 3,000,000 cubic feet. The present capacity of 6,000,000 cubic feet is sufficient, Mr. John Keillor, gas engineer says, to meet this winter's requirements only and the new addition will suffice until 1932. The Company is, however, making its plans for a much longer period and estimates that Greater Vancouver will require 25,000,000 cubic feet of gas by 1947, to meet which an ultimate expenditure of $5,600,000 will be required on the new plant during the next twenty years.

BOARD OF TRADE ANNOUNCEMENT.

Safeguarding of Key Industries.

The Treasury have made an Order under Section 10(5) of the Finance Act, 1926, exempting the following articles from Key Industry duey from 8 October, 1927, to 6 March, 1928 :— Didial (Ethyl morphine diallyl barbiturate); Ethylene bromide; Lead tetra-ethyl; R. Potassium hydroxide (R. Potassium caustic, R. Potassium hydrate).

The Treasury Order will be published shortly.

KODAK COMPANY'S ENTERPRISE.

Messrs. Howse & McGeorge, Ltd., pharmaceutists of Nairobi, East Africa, announce that their business has been taken over by Kodak (East Africa), Ltd., a new subsidiary company of Kodak, Ltd., of London. The new organisation will operate from Nairobi, Kenya Colony, and distribute all classes of pharmaceutical and photographic supplies throughout Uganda, Tanganyika Territory and Kenya Colony.

Both Mr. Howse and Mr. McGeorge are directors of the new company.

SCIENTISTS AND COAL.

Official announcement comes from the Carnegie Institute of Technology in Pittsburgh, Pennsylvania, U.S.A. ,that a second International Conference on Bituminous Coal will be held there during the week of November 19, 1928.

Decision to call a second congress of world scientists and fuel technologists has been made, it is announced, as a result of the widespread interest aroused throughout the world by the first Conference on Bituminous Coal held at the Carnegie Institute of Technology in November, 1926.

The first conference, which was devoted to discussions of the better utilisation of bituminous coal, was attended by 1,700 persons, including delegates from thirteen different countries. Among distinguished Euorpean scientists who addressed the conference were Dr. Friedrich Bergius, Heidelberg, Germany; Professor Franz Fischer, director, Institute of Coal Researcr, Mulbeim-Ruhr, Germany; General Georges Patart, Paris, France; Dr. Cecil H. Lander, Director of Fuel Research, Dr. R. Lessing, consulting engineer, Geoffrey M. Hill, consulting engineer, and Harald Nielsen, London, England.

Although no definite program plans for the second conference have been made, it is expected that the 1928 session will cover the latest developments in obtaining substitutes for gasoline from coal, power from coal, low and high temperature distillation processes, smokeless fuel, gasification of coal, utilisation of coal tar products, coal as a source for fertiliser, and coal in relation to the production of fixed nitrogen.

Dr. Thomas S. Baker, president of the Carnegie Institute of Technology, who called the first conference, visited Europe this past summer for the purpose of discussing phases of the second conference with eminent scientists in France and Germany. He plans to pay another visit to Europe in 1928 to invite speakers and delegates.

IMPORTANT FEDERATION OF BRITISH INDUSTRIES CONFERENCE.

On the invitation of the Director of the Federation of British Industries, a private meeting of the Directors of Industrial Federations in Belgium, Czecho-Slovakia, France, Germany, Holland, Italy, Sweden and Switzerland, was held in London on October 3 and 4. The Director of the Austrian Federation was prevented at the last moment from coming.

The meeting discusse dcurrent questions which are occupying the attention of the various European Industrial Federations at the moment, and, in particular, gave its attention to the method whereby the Industrial Federations could co-operate in support of the resolutions of the World Economic Conference, and of the Stockholm Congress of the International Chamber of Commerce, upon such questions as Customs Nomenclature, Double Taxation, Import and Export Restrictions, and the Preparation of Industrial Statistics. A further exchange of views took place as to the forms of organisation taken by the Industrial Federations in the various countries.

The discussions were of a useful character, as tending to indicate methods whereby European Industrial Organisations could improve the present method of interchanging views upon current economic questions of common interest.

BISULPHIDE OF CARBON (CONVEYANCE IN TANK WAGONS) REGULATIONS, 1927.

SCHEDULE.

(A) MECHANICALLY DRIVEN ROAD TANK WAGONS.

1. The vehicle, including the tank and fittings, shall be strongly constructed of fire-resisting materials and shall be maintained in thoroughly good condition. The engine and fuel tank shall be effectively screened from the tank by a fire-resisting shield carried up above the top of the tank and down to within twelve inches of the ground, and the exhaust shall be wholly in front of this shield. The tank shall be securely fastened to the frame of the vehicle. A space of not less than six inches, which shall be left clear and unobstructed except for any part of the framework of the wagon, shall intervene between the tank and the fire-resisting shield.

(B) HORSE-DRAWN ROAD TANK WAGONS.

2. The vehicle, including the tank and fittings, shall be strongly constructed and the tank shall be securely fastened to the body of the vehicle.

GENERAL PROVISIONS.

3. The tank, if of more than 500 gallons capacity, shall be divided into self-contained compartments, no one of which shall contain more than five hundred gallons.

4. Discharge valves shall be fitted only at the top of the tank and discharge shall be by the pressure of an inert gas or of water. The valve for the attachment of the pressure pipe shall be fitted with a cover, which shall be kept closed and locked except during the operation of emptying the tank, and the keys shall be retained by a responsible person.

5. The filling and discharge pipes shall be carried down nearly to the bottom of the tank and shall each terminate i nsuch a way as to provide at all times a liquid seal at the bottom of the pipe.

6. The dipping pipes shall be carried down to the bottom of the tank, and any openings in them other than the upper orifice shall be covered with fine wire gauze of not less than 28 meshes to the linear inch.

7. *The ventilating openings shall be covered with fine wire gauze of not less than 28 meshes to the linear inch, protected by covers when not in use.*

THE PHOTOGRAPHIC EXHIBITION.

The 72nd annual exhibition of the Royal Photographic Society was held recently at 35, Russell Square. In addition to the pictorial and portraiture exhibits the technical and scientific sides of photography were also well represented. New kinematograph cameras were demonstrated, stereoscopes were on view and trade exhibitors showed the latest qualities in lenses, plates, papers and apparatus.

Interesting colour prints and transparencies were shown as well as photomicrographs, radiographs, and astronomical, geological, aerial, metallurgical and spectral prints. A valuable micrograph of Niépce, which required a microscope to render it visible, was stolen during the exhibition.

Of greater chemical interest were the dye toning effects obtained by the use of organic dyestuffs. The results with various colour photography processes were also interesting and show considerable improvement.

Many of the photographs of natural history objects reached a high order of merit.

THE INSTITUTE OF METALS.

METALS IN MODERN TRANSPORT.

Dr. L. Aitchison, of Birmingham, gave the opening lecture of the annual meeting of the Institute of Metals at Derby, on Tuesday ,September 6, under the chairmanship of Sir John Dewrance, K.B.E., President of the Institute.

Dr. Aitchison said that the reasons for the employment of the non-ferrous metals in our various systems of transport are very similar to those that govern their utilisation in all other branches of engineering. The non-ferrous metals and alloys are only needed when they can offer certain chemicals o rphysical properties that are required by the engineer and that are not possessed by iron and steel. In general, the properties that lead to the greatest employment of the non-ferrous metals and alloys are :—

(1) A high resistance to corrosion.

(2) *High values of thermal or electrical* conductivity.

(3) A low value of specific gravity.

In addition, the properties of ease of machining, ease of cold working and simplicity of casting contribute to the wider usefulness of the materials.

The use of non-ferrous metals on account of high electrical or high thermal conductivity is particularly illustrated by the purposes to which copper is put. This metal enters very extensively into the construction of electrical plant, whilst its thermal conductivity is made use of in boiler tubes and the like.

A high resistance to corrosion is a conspicuous feature of nickel and its allolys. These metals are not very etxensively used in connection with transport systems, but a fairly prominent example of this service is found in cupro nickel condenser tubes. Many examples of good resistance to corrosion are found in the alloys of copper. Typical illustrations of the use of this metal and its alloys on this account occur in condenser tubes and turbine blading, as well as in gun metal and phosphor bronze castings, which are extensively employed in ship construction.

The use of metals having a much lower specific gravity than iron and steel, and having at the same time mechanical properties which are comparable with those of the ferrous metals, is of great importance in transport systems. The alloys that are actually employed are those based upon aluminium and magnesium. The alloys of aluminium at the present time are of course much more extensively employed than the alloys of magnesium, and the aluminium materials find their way into a great many parts, both in the cast and in the wrought condition. A variety of aluminium casting alloys can be employed, and are more or less interchangeable, but the majority of the wrought parts are made in Duralumin. The way in which weight saving can be achieved by the adoption of light alloys, is illustrated in the lecture by reference to the method of construction of rail coaches and food containers, and to their use in constructing panels and structural sections in tramcars, motor cars and motor buses. In addition, aluminium alloys are extensively used for a large number of castings that are incorporated in automobile engines, whilst in the wrought state they serve admirably in a number of engine parts and in the structure of the vehicle.

An important branch of modern transport is that comprised by aeroplanes, seaplanes, flying boats and airships, and in all these branches of transport, lightness is a property which is prized very greatly. The employment of the non-ferrous metals in these different forms of aeronautical structure, as well as in the engines of the value to the engineer of the low specific gravity of the lifht aluminium alloys—these being one-third of those of the irons and steels.

Another field into which non-ferrous metals enter very largely is that of anti-friction materials. These are of various kinds, havin gtin, or lead, or copper as their basis. They are able to function in a way that no steel or iron is able to rival.

THE COPPER-MAGNESIUM ALLOYS.

By W. T. COOK, B.Sc., A.I.C., AND W. R. D. JONES, M.Sc., Member.

(*Before the Institute of Metals.*)

SYNOPSIS.

This report deals with an investigation on the forging of copper-magnesium alloys, and is a continuation of that given on the casting of these alloys and the mechanical properties of chill cast bars. The properties of the alloys in the forged and heat-treated conditions have been determined and examined. The ductility of these alloys depends primarily on the forging temperature. If this temperature be low the elongation and the reduction of area are impaired seriously, and the values are not restored by subsequent heat-treatment. The mechanical properties of copper-magnesium alloys con-

taining up to 11 per cent. copper are not improved by simple heat-treatment, which causes a general decrease in test values. The addition of copper to magnesium up to about 2 per cent. is beneficial. Beyond this amount the increase in tenacity is small, whilst there is a regular decrease in ductility and a proportional increase in specific gravity. There is no advantage in adding more than this amount of copper to magnesium either for castings or for forgings. To obtain the best results the forging temperature must be controlled, and care must be taken to guard against any possibility of cold-shut when casting ingots for forging.

FORTHCOMING EVENTS.

UNIVERSITY COLLEGE.

Gower Street, London, W.C.1.

Tuesday, October 18, at 5 p.m.—Prof. A. J. D. Hall, M.D., F.R.C.P. : " The Static Reflexes of Magmas : How Animals Get Right-way-up and Keep So."

Wednesday, October 19, at 5.30 p.m. — Mr. J. H. Helweg : " The Memoirs of Leonora Christina, of Denmark."

Thursday, October 20, at 5.15 p.m.—Prof. J. E. G. de Montmorency : " Tribal Constitutional History."

ROYAL INSTITUTE OF PUBLIC HEALTH.

3, Russell Square, London, W.C.1.

Wednesday, October 19, at 4 p.m.—Prof. S. Lyle Cummins, C.B., Ll.D., M.D. : " Tuberculosis as a Social Disease."

Monday and Tuesday, October 17 and 18, at 4 p.m.—Prof. R. Bingnoghe, M.D. : " The Twort-d'Herelle Phenomenon."

Thursday, October 20, at 4 p.m. — "Some New Research on Relapsing Fever."

INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, London, W.C.2.

Thursday, October 20.—

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Tuesday, October 18, at 5.30 p.m.—Council Meeting.

INSTITUTE OF METALS.

Birmingham Local Section. — Thursday, October 20, at 7 p.m., at the Engineers' Club, Waterloo Street.—F. W. Aston, M.A., D.Sc., F.R.S. : " Isotopes."

THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

30, Russell Square, London.

Wednesday, October 19, at 8 p.m. - S. M. Gluckstein, Esq., M.C. (of Messrs. J. Lyons and Co.), will give a talk on " Chemists and Dividends."

THE OPTICAL SOCIETY.

Thursday, October 13, at 7.30 p.m., at the Imperial College of Science and Technology, South Kensington.—Prof. L. C. Martin, D.I.C., D.Sc. : " Experiments in Ultra-Violet Refractometry." Guy Barr, B.A., D.Sc. : " The Construction of Wave-Length Scales for Spectrograms."

SOCIETY OF GLASS TECHNOLOGY.

Darnall Road, Sheffield.

Wednesday, October 18, at 6 p.m.—Meeting of Furnace Survey Committee.

7.30 p.m.—Informal Dinner at the King's Head Hotel.

Wednesday, October 19, at 10.15 a.m.—Visit to glass works of Messrs. Beatson, Clark & Co., Ltd., Rotherham. 11.15 a.m., Meeting of Council in the offices of Messrs. Beatson, Clark & Co., Ltd. 2.30., General Meeting at the Applied Science Department, The University of Sheffield. Mr. Walter Butterworth Sen., M.A., J.P., Introductory Address. J. F. Hyslop, B.Sc. : "Opal Glass—Crystal Growth and Impact Brittleness." Francis Buckley : " The Birmingham Glass Trade, 1740-1833." E. J. C. Bowmaker, B.Sc., and J. D. Cattwood, M.Sc. : " The Detection of Selenium in Decolourised Bottle Glasses."

ROYAL MICROSCOPICAL SOCIETY.

20, Hanover Square, London, W.1.

Wednesday, October 19, at 8 p.m.—Mr. Conrad Beck, C.B.E. : " Note on Diatom Structure and Resolution." Prof. H. Graham Cannon, M.A., D.Sc., and Dr. A. J. Grove, M.A., D.Sc. : " Aerating and Circulating Apparatus for Aquaria and General Use." Dr. A. J. Grove, M.A., D.Sc. : " A Simple Made Hot Plate for Flattening Paraffin Sections." Dr. Osakar Heimstadt : " Stereoscopic Vision with the Microscope." Prof. Paul Vonwiller : " Microscopy with Incident Light and its Application to Objects." Mr. Douglas P. Wilson, B.Sc. : " Note on a Method of Obtainin Long Working Distances with Low Power Objectives."

NOTICES OF BOOKS.

A Dictionary of Applied Chemistry. By SIR EDWARD THORPE, C.B., LL.D., F.R.S. Vol. VII. Thalenite to Z, with Index to the Complete Work. Pp. viii + 766. Price 60s. net. London : Longmans, Green and Co., Ltd., 39, Paternoster Row, E.C.4.

This great work is complete in seven volumes, the last one of which, together with a complete index to the whole work, has just been issued. Vol. I extends from A to Calcium; Vol. II, Calcium to Explosion; Vol. III, Explosives to Kyrofin; Vol. IV. L to Oxydisilin; Vol. V. Oxygen to Rye; Vol. VI. S-acids to Tetryl; and Vol. VII. from Thalenite to Z. All but the last two volumes had been issued when the author died, but as these two were in an advanced stage towards completion, no trouble arose to mar the uniform excellence of the work. The volumes are much more than a mere Dictionary, and merit more the title of Chemical Encyclopædia, the meanings are explained so fully and where necessary amplified with useful incidental information. No scientific library can be considered at all complete without this encyclopædic work.

The learned contributors to Volume VII. number over two dozen, and the last Volume is fully up to the high standard set out by Sir Edward Thorpe in commencing the book. We are particularly interested in the present volume, as on the first page of the context thalium is dealt with, and we are therein reminded that thalium was discovered spectroscopically in 1861 by Sir William Crookes, and fully described by him in the *Chemical News*, 1861, Vol. III., p. 193. Further, it is shewn that H. N. Warren observed it in platinum and its ores and it was described by him in the *Chemical News*, 1887, Vol. 55, p. 24.

Attached to the present volume is a General Index to the whole seven volumes, and some idea of the magnitude of the work will be given by the size of the index, which extends from page 611 to 765—a fair-sized book in itself.

Almanac of the Seventh Congress of Czechoslovak Engineers and Architects. Pp. 482.

The Association of Czechoslovak Engineers and Architects recently held its seventh congress at Mladá Boleslav. Although formed in 1914 its activities were restricted until 1918, and now the members are in a position to develop their interest in the various branches which are represented in the Association. All are engaged in some branch of technology and all work for the common good of scence. Eminent persons in Czechoslovakia were asked to give their views and to supply an answer to the question : " In which direction is it possible for a greater development to take place and in which branches is it possible to secure greater progress by more intensive work? " Several answers are instructive as well as interesting.

For instance, Engineer Stan. Špaček, who represented technical-economic section of the Ministry of Foreign Affairs (Public Works), replied that (1) the commercial side of the engineers' work was neglected; (2) industrial organisation could be improved; and (3) administration and political and economic relations could be streugthened.

Vaclav Klement, councillor for the Skoda Works, replied that if the engineers would specialise in making improvements in the motor industry the country would be able to supply the local market and those countries for which it finds an outlet for other goods.

Dr. Engineer Vl. Sýkora pointed out that Czechoslovakia should be able to manufacture optical goods, measuring instruments, typewriters and calculating machines, as well as medical and scientific instruments.

The history of the old firm of Laurin and Klement from its commencement till it was merged into the Skoda Works was described by Engineer Josef Hanus. The importance of modern manufactures in connection with present-day economic developments and also for defence during war, form the subject of another address by Capt. L. Buchaček, who describes the activities of the Army Institute for Fuel Research in Prague.

Engineer K. Laskot, director of the Society for Power Alcohol, gave an account of the industrial applications that were possible uses for alcohol. The importance of the alcohol industry in war was described by Engineer F. Šťastný.

Dr. O. Souček described the original Bohemian construction of motor vehicles with double driving (*e.g.*, benzine-electrical " Praga " cars). Engineer K. Špaček summarised the position of road construction and improvement in Czechoslovakia. Dr. Cyrill Krauz discussed the application of organic chemistry in military matters. Dr. A. Majrich dealt with war gases in thé service of the State. Dr. Oldrich Jurek also read a paper on " Gas Warfare and Poison

Gases." Engineer F. Hruska discussed the flour question in Czechoslovakia.

Another subject which received attention was long-distance telephony, and Vladimir Laucky explained the construction of the wireless stations equipped for this work. He also described how electron valves (lamps) served as telephonic intensifiers, and outlined the essentials for good transmission of speech by both cable and wireless. Jaromir Svoboda dealt with the radio stations at Prague, Brno, and Bratislava. Mr. J. Polák described the important semiprecious stone and glass industries of North Bohemia, especially Turnov, and Dr. Vaclav Čtyroky dealt with Jablonec glass industry. The textile industry of North Bohemia was described by Prof. J. Cerman, Engineer V. Just read a paper on "Carborundum and Electrolite."

The general situation in the industries of pharmacentical chemistry was reviewed by Ant. Snižek, director of the Prague firm "Medica." The work concludes with a very agreeable article by Karel Sellner, district school inspector, on the history of Mladá Boleslav, its early glory ,decay and ruin and its recent revival as an important industrial town.

Mention is also made of local special schools such as the Agricultural school at Jičin, Higher Economic school at Poděbrady, Special Economic school at Jilemnice and others, which are becoming more and more important. The great importance to Czechoslovakia of the health resorts is shown by Karel Nováček in his article on Podebrady. JUC. P. Kverka.

Chemical Elements and their Compounds. (An Introduction to the Study of Inorganic Chemistry from Modern Standpoints.) By J. A. V. Butler, D.Sc., Lecturer in Chemistry in the University of Edinburgh. Pp. XII + 200, with numerous illustrations. Price 6s. London : Macmillan & Co., Ltd., St. Martin's lane, London, W.C.2.

This is quite an interesting book, not only for the manner in which chemistry is dealt with from the modern standpoint, but also for the historical information given, notably bearing on the early chemists and their efforts to unravel the secrets of nature, many of which have been since revealed. The work is based on a series of lectures delivered to students reading for the B.Sc. degree, but it will be found equally useful for the private student, and also interesting to intelligent members of the public.

U.S.A. Department of Commerce.—
Official Publications.

Fluorspar, Its Mining, Milling and Utilisation. With a Chapter on Cryolite. Pp. 186. 35 cents.

Fuller's Earth in 1925. 5 cents .

Summary of Mineral Productions in Foreign Countries (1920-1924). 15 cents.

Gold, Silver, Copper, Lead and Zinc in Idaho and Washington in 1925 . 10 cents.

Coke and By-Products in 1924. 25 cents.

Acid Processes for the Extraction of Alumina. Bulletin 267. Price 15 cents.

Fuel Briquets in 1926. 5 cents.

Ceramic Properties of Some White Burning Clays. Bureau of Standards Circular 325. Price 20 cents.

Coal Dust Explosion Tests in the Experimental Mine 1919 *to* 1924 *inclusive.* Bulletin 268. 35 cents.

Precipitation of Gold and Silver from Cyanide Solution on Charcoal. Technical paper 378. Price 15 cents.

Iron Blast Furnace Reactions. Technical Paper 391. Price 15 cents.

Sulphur and Pyrites in 1925. Price 5 cents.

Resistance of Metal. Mine Airways Bulletin 261. 35 cents.

Technology and Uses of Silica and Sand. Bulletin 266. 40 cents.

Methods of Exploring and Repairing Leaky Artesian Wells. (Department of the Interior.)

Large Springs in the United States. Water Supply Paper No. 557.

Geology of the Cat Creek and Devil's Basin Oil Fields in Montana. (With maps).

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

25,022.—Alcock, H. E.—Manufacture of phosphoric acid, etc. September 22nd.

25,062.—Bregeat, J. H. — Manufacture of potassium carbonate, etc. Sept.-22nd.

25,182.—Delco-Light Co.—Methyl ether. September 23rd.

24,645.—I. G. Farbenindustrie Akt.-Ges. —Production of solid calcium cyanide, etc. September 19th.

24,910.—Schlaugk, Ges., M.—Manufacture of sodium sulphide. September 21st.

Specifications Published.

253,090.—Dessauer, F. — Apparatus for analysing substances by means of Rontgen or cathode rays.

253,918.—Boehringer, A. (trading as Boehringer Sohn, C. H.).—Process for the production of disinfecting agents.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

275,590.—Synthetic drugs. — Binz, A. and Rath, C., 42, Invalidenstrasse, Berlin.

Nitropyridine arsinic acids are prepared by treating substituted pyridine arsinic acids with strong nitrating agents. Substituted pyridine arsinic acids mentioned are those containing hydroxyl or halogen groups, *e.g.*, 2-oxy- and 2-halogen-pyridine-5-arsinic acids. The products, like the amino compounds into which they may be converted by reduction, possess therapeutic properties. An example is given of the preparation of 2 - oxy - 3 - nitropyridine - 5-arsinic acid by adding fuming nitric acid to a sulphuric acid solution of 2-oxypyridine -5-arsnic acid. The product may be reduced to 2-oxy-3-aminopyridine-5-arsinic acid.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

OBITURIN BRAND.

481,544.—Chemical substances in class 3, for use in determining whether life is extinct.—H. R. Napp, Limited, 3 and 4, Clements Inn, Kingsway, London, W.C.2. September 28th.

GESTY.

483,679.—Chemical substances prepared for for use in medicine and pharmacy.—John James Pickering, trading as Woods Pharmacy, 50, High Street, Windsor. September 28th.

SOLATOR BRAND.

483,754.—Chemical substances prepared for for use in medicine and pharmacy.—H. R. Napp, Limited, 3 and 4, Clements Inn, Kingsway, London, W.C.2. September 28th.

483,628.—Illustration of an apple and the word "APPLEDOC," for chemical substances prepared for use in medicine and pharmacy.—Stanley William Tanfield, 46, St. James' Place, London, S.W.1. September 28th.

GENERAL INDEX TO THE "CHEMICAL NEWS"—VOLS. 1 TO 100.

This large volume contains a detailed Index to the first 100 volumes of the *Chemical News*, and will be found of great value to all interested in Chemical, Engineering, Electrical and General Scientific subjects. It has been compiled with great care, is handsomely bound in red cloth, and has been produced at great expenditure of time, labour and money. Carriage paid, Great Britain, 21/- net; Carriage paid to Foreign Countries and the Colonies, 23/- net.

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THE CHEMICAL NEWS

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SOME ASPECTS OF THE PRESENT-DAY INVESTIGATIONS OF PROTOPHYTA.

PROF F. E. FRITSCH, D.Sc., PH.D.,
President of the Botany Section.

(British Association for the Advancement of Science.—Leeds, 1927.)

(Continued from Last Week.)

An attempt has been made in various quarters to find a solution of the species problem in the method of "pure culture." It is well, however, to realise the limitations of the method, and it may be doubted whether, except from the standpoint of physiology, the large amount of labour that has been expended on such work has been justified. Two monographs of the genus *Scenedesmus* based on pure cultures have appeared in recent years, but the authors do not agree in any way as regards the limits of the species. It cannot be denied that, as a supplement to frequent direct observation, pure cultures may be of considerable value and that under certain circumstances (*e.g.* in the study of subterrannea soil-Algae or of endophytes) they are essential. The conditions are, however, for the majority of Algae so artificial and of necessity in certain respects so uniform as compared with those in nature, that the results obtained require to be interpreted with great caution.

Indoor conditions, especially in laboratories, are already as a general rule sufficiently harmful to freshwater Algae, and the occurrence of various bizarre forms in agar-agar or gelatine cultures, whilst of some interest from the point of view of comparative morphology, cannot be regarded as proving that such tforms belong to the normal cycle in nature of the Alga in question. Conversely because, in a pure culture, a given Alga varies only between very narrow limits, that is no proof that these represent the full range of its morphological variation, but merely that under the peculiar circumstances of a pure culture it exhibite this "habitat-form." No systematist would be satisfied with a knowledge of a higher plant derived only from specimens grown in a botanic garden, where conditions are by no means as artificial as they often are in an algal culture.

I have offered these comments on the study of Algae in pure cultures, not with an ywish to deny the utility of the method in certain directions, but in order to make clear that it can in no way replace direct observation of the Alga in nature. Here alone we have the natural form, subjected to the normal seasonal changes and other meteorological influences, holding its own in competition with the other living members of its environment, and exposed to the influence of the frequent changes in the organic and inorganic content of the water. It is a mistake to suppose that careful periodic observations cannot in most cases lead to the desired goal. The work will be laborious, but the labour will be repaid by the results. Immersion of glass slides or cover-glasses in the water will often afford valuable comparative data on the early stages of development.

Since a large number of botanists are professionally occupied in towns, such direct observation of Algae is a matter of some difficulty and in some cases of impossibility. Under these circumstances work with algal cultures is easiest, and this has no doub

been a factor in its rather widespread adoption. It is a matter of regret that practically no facilities exist in this country for the direct study of freshwater Algae and of the many limnological problems that are linked up with it. There are no freshwater biological stations, as far as I am aware, apart from the Experimental Station at Alresford, Hants, of the Ministry of Agriculture and Fisheries. Nor have there been many researches in this country dealing with the biology and ecology of freshwater Algae, although thanks to the Wests and to Dr. Pearsall some very valuable work has been done on the waters of the Lake District; Dr. Griffiths, too, despite the difficulties, has made considerable progress with the study of the freshwater phytoplankton of the lowlands.

It is specially to be deplored that there is no biological station with a permanent staff on the Norfolk Broads, where many problems of general interest could be attacked, and which would be within fairly easy reach of many of our universities. The benefits likely to accrue from the pursuit of investigations at such a station would by no means be confined to the pure aspects of our science, since the study of freshwater Algae is fundamental for the understanding of the general biological features of a piece of water and is intimately related to its productivity in animal life, including the diverse kinds of freshwater fish. Much profitable and important research in this direction emanates from Sweden, Germany, and other European countries, nearly all of which possess several well-equipped and well-staffed freshwater stations, but to this we, as a country with a large area of freshwaters, contribute practically nothing.

SCIENCE AND INVENTION THROUGH THE AGES*.

The development of science and the advance of civilisation through inventions reads like a fairy story especially in the work of the authoress of *Science Through the Ages*.

The subject is one which lends itself to a variety of treatments. The chronological one was followed in my *Brief Outline of the History of Science* (THE CHEMICAL NEWS), but in the volume under review each development is traced separately, yet even here it has been possible to keep, in the main, to the first order.

How fire was first observed, conserved and finally reproduced is well told and a vivid picture is drawn of the rock melting under a fire whereby a stream of molten metal was first prepared—to be used for hunting weapons as the Bronze Age dawned.

The evolution of food conservation also constitutes a fascinating story. The "cave man" kept himself alive by a food supply obtained whilst he was constantly on the move. Then came the era of crop-planting and harvest and early attempts at preservation by cooking. Simultaneous "finds on the way from clay to china," permitted further baking processes and enabled Napoleon's prize offered for a successful container for preserving foods to be won at the beginning of the last century, since when it has been possible to preserve almost all kinds of foodstuffs in cans for long periods. Pasteur's medico-scientific researches elucidated the cause of decay and decomposition in foods and paved the way for further improvements and other methods (*e.g.*, chilling).

Another romance is the development of power. It was a Dutch farmer who is credited with having pitted wind against water. Pumps had been used to draw water from a well, but Alkmade constructed a windmill so that the sails were revolved by the prevailing north-west wind. Later they were constructed so as to utilise any wind.

The development of time measurement is also very interesting. The earliest records of time measuring come from the Babylonians, who also first studied the changes observable with the sun, moon and stars. They introduced the twelve signs of the zodiac and instituted a year of twelve months, a week of seven days and a day of 24 hours. The time was also told by a sun-dial.

The Chinese, and independently, the Indians and the Egyptians invented water clocks for use in bad weather and at night. Little advance was made on this mode of time measurement until Galileo introduced the pendulum principle. Later, in 1735, Harrison, in England, produced clocks with a compensated or gridiron pendulum. These were of great service at sea..

From the keeping of records on stone tablets, then papyrus and parchment to the manufacture of paper and the invention of printing, forms another instance of the tremendous boon that science has conferred upon mankind.

The succeeding sections of *Science Through the Ages* deal with more modern developments, *e.g.*, fuel for power, *i.e.*, James Watts' improvement of the steam engine, Stephenson's construction of the "Rocket," and the later utilisation of coal for gas and as a source of energy.

A section on the wonders of light refers to the new vistas opened up by the invention of the telescope and microscope and the ultimately successful recording of images by photograpby. The harnessing of electrical power following on Oersted's discovery of its action on a magnet and Faraday's dynamo is traced in another section. But perhaps the greatest of all are the inventions which have made aviation possible and successful. It was in 1903 that the brothers Wright first constructed a machine which stayed in the air 59 seconds, and covered 85 feet. By 1909 improvements had been made which enabled Blèriot to fly the Channel. In 1919 the Atlantic was crossed by Sir J. Alcock and Sir W. W. Brown. Others have flown across continents aud to Australia.

Other important developments, too numerous to mention, are dealt with in Miss Lansing's excellent book. Its one weak place is in connection with a purely chemical subject, *viz.*, the dyeing of cloth. Here the terminology is inaccurate, but the meaning will be clear to those familiar with the subject.

A moment's reflection is all that is needed to recall the benefits conferred upon mankind by the labours of the persistent band of scientists through the ages, and Miss Lansing has written a book very suitable for young readers and at the same time equally suitable for adults who wish to learn something of the achievements of scientific discovery and invention even though they do not possess a wide knowledge of the subject.

J. G. F. DRUCE.

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* *Science Through the Ages*, by MARION FLORENCE LANSING. Pp. 251. London: George G. Harrap & Co. 1927. Price 2s. 6d.

GAS v. ELECTRICITY.

The respective advocates of the above heating and lighting agents are just now, on the approach of the cold, dark weather, exhibiting considerable activity.

ELECTROLYSIS OF COPPER PYRITES.

By ROBERT SAXON, B.Sc., F.C.S.,

Member of the American Chemical Society.

Repeated attempts to get the copper to leave the iron as sulphide meet with such scant success that one is forced more and more to the conclusion that *copper pyrites is iron cupri-sulphide*, the copper being held with the sulphur as anion by the more positive iron. The pyrites is in lump form to make weighing easy, though powdered and daubed on the anode with adhesive of an rapid decomposition. With sodium chloride as electrolyte using carbon electrodes very little action takes place. The addition of ammonium chloride assists considerably the disintegration, and this salt is mixed with every electrolyte to ensure the life of the carbon as chlorine comes off in preference to oxygen and does not attack the carbon as oxygen does. The addition of alkaline borates, carbonates, silicates, or chromates makes very little difference to the meagre yield. The sulphates assist slightly. The alkaline earth carbonates have a much greater effect the carbonate decomposing leaving the chloride in solution along with ferrous chloride of decided green. Prolonged action gives ferric chloride. There is hydrogen sulphide given off but the pyrites becomes richer in copper sulphide assuming the rainbow tints of peacock ore from brassy pyrites. The iron is never delivered as sulphide but always as ferrous followed by ferric hydrate as the action continues along with a little chloride. Thus the iron behaves exactly as a strong basic metal like sodium would do giving the hydroxide. Lead carbonate gives quicker and more abundant yields than those of the alkaline earths, giving at the anode the chloride, oxide, and metal. At the same time there is sulphuretted hydrogen given off. The action varies with the temperature which if raised causes the chloride to pass into solution to deposit the metal, and incidentally increase the yield of ferric chloride. Lead carbonate was chosen because it holds a restraining hand on the lead which would form fresh chloride if in a soluble salt. It lets off the lead only as heat and chlorine are developed. The following shows the weighings of the residual pyrites after two hours running of the current between each two :—

Weight taken	6.995 gr.
NaCl electrolyte	6.975 ,,
+ borax	6.950 ,,
+ sulphate	6.950 ,,
AmCl, NaCl, $BaCO_3$	6.920 ,,
Second time	6.897 ,,
Third time	6.873 ,,
$PbCO_3$, AmCl, NaCl	6.824 ,,
Second time	6.775 ,,
Third time	6.725 ,,

As the pyrites become richer in copper sulphide it is probable tbat this might get in the way and retard action towards the later stages.

ON THE LATTICE-CONSTANT OF METALLIC COBALT.

By Sinkiti Sekito.
(Tôhoku Imperial University.)

In 1921 A. W. Hull determined the lattice-constant of metallic cobalt by means of X-ray analysis. Filings from cast cobalt (99.7 per cent. pure) showed the spectrum of perfect hexagonal close-packed lattice with no trace of the spectrum of a cubic lattice mixed with it, but after annealing the specimen in hydrogen at 600° C. for 6 hours, it showed the simultaneous presence of both a hexagonal close-packed lattice and a cubic lattice in nearly equal proportions. Powdered cobalt, obtained by reducing cobalt oxide in a hydrogen stream at 600° C., gave almost exclusively the face-centered cubic lattice, only a very faint trace of the hexagonal being detected. Cobalt obtained by rapid electrolysis from a solution prepared by dissolving cast cobalt in sulphuric acid was proved to consist of a nearly equimolar mixture of a hexagonal close-packed and a cubic lattice.

According to Assistant Professor H. Masumoto of our Institute, an allotropic transformation occurs, in cobalt, at 477° C. during heating and 408°C during cooling. He also concluded from his various experiments that, below this transformation point, cobalt assumes a hexagonal close-packed lattice as its stable form, and, above it, a face-centred cubic lattice, but the confirmation of his conclusion required the X-ray evidence, which is furnished by the present investigation.

Summary.

(1) The stable form of metallic cobalt at an ordinary temperature is a hexagonal close-packed arrangement, while, above the transformation point, a face-centred cubic lattice is stable. This result confirms the conclusion arrived at by Assist. Prof. H. Masumoto.

(2) The lattice-constant and the axial ratio of the hexagonal form are 2.498 and 1.622 respectively, while the lattice-constant of the cubic form is 3.558.

(3) Electrolytic cobalt is not always a mixture of the crystals of hexagonal and cubic lattices.

(4) The amount of the discontinuous change calculated from the lattice-constant is in satisfactory agreement with the result obtained by Masumoto from his elongation-temperature curve.

In conclusion the present writer wishes to express his cordial thanks to Professor K. Honda, under whose kind guidance the present investigation has been carried out, and also thanks are due to Mr. S. Otuki for his zealons assistance dnring the course of the present investigation.

GOVERNMENT CHEMIST.

Report upon the Work of the Government Laboratory for the Year Ending 31st March, 1927, with Appendices.

The chemical work of the following Departments is performed wholly or in part in the Government Laboratories :—Admiralty, Ministry of Agriculture and Fisheries, Board of Ariculture for Scotland, Air Ministry, Colonial Office, Crown Agents for the Colonies, Board of Customs and Excise, Fishery Board for Scotland, Ministry of Health, Board of Inland Revenue, Ministry of Pensions, Post Office, Department of Scientific and Industrial Research, Scottish Board of Health, Home Office, Board of Trade, War Office, Forestry Commission, Privy Council and Office of Works. The Laboratory also renders "Reserved Services" to the Government of Northern Ireland in respect of dutiable goods, and performs certain services for the High Commissioner for India, the Crown Agents for the Colonies, the Corporation of Trinity House, the Commonwealth of Australia, and the High Commissioner for Southern Rhodesia, on a repayment basis.

The work for most of these Departments is carried out at the laboratory at Clement's Inn Passage. The laboratory at the Custom House, London, deals especially with Customs samples, while the chemical stations, to which reference is made in connection Excise, deal with Customs samples and some

Excise samples. In addition the Department maintains the laboratory in the Geological Survey Museum for the analysis of ores for the Survey, and carries out the inspection of foods and supplies for the War Office at the Supply Reserve Depot, Deptford, where also there is a laboratory.

The total number of samples examined in the course of the year, including those dealt with at the chemical stations, was 469,642, as compared with 445,606 in the preceding year, an increase of 24,036. There was a decrease in the number of samples examined at the Custom House branch of 3,594, but the number examined at Clement's Inn showed an increase of 14,716, and at the chemical stations an increase of 12,914. The samples of wine increased from 106,395 to 122,749, but there was again a decrease in the number of tea samples, the number being 34,957, compared with 39,391 last year and 58,022 two years ago. This decrease is due to the examination of the tea being carried out to an increasing extent by trained tea inspectors, who send special samples only to the laboratory. There was an increase of 1,297 in the samples of exported tobacco and snuff, indicating that an increase in exports referred to last year has been maintained. There were increases in the numbers of samples of cocoa goods, and imported and exported spirituous preparations, and also in the number of samples examined in connection with the subsidy on British sugar. The new duties on silk and artificial silk necessitated the examination of over 22,000 samples during the year, and the work in connection with the Safeguarding of Industries Act again involved the examination of 10,000 samples.

Admiralty.

Chemical work is performed for the Admiralty in connection with the contract department, the naval yards, the engineering department and the hospitals. The contracts branch submitted 47 samples of food on tender for report as to conformity with specification and opinion as to relative merits. The technical examining officers at the victualling yards forwarded 208 samples from supplies for examination and report, many of the samples being submitted with the object of preventing the issue of canned goods contaminated with metals.

Other samples to the number of 86 included soaps, tin plate, cordage, canvas, plated ware, rubber, leather for the amount of mineral acids present, feathers to ascertain the extent of purification, cloths for the nature of the mineral matter, glass and enamelled ware for the presence of lead, and an oilskin fabric.

In addition to the examination of the foregoing samples of foods and general stores, the determination of the salinity of 1,825 samples of sea-water was carried out.

Board of Agriculture for Scotland.

One hundred and seventy-five samples of imported dairy produce and 15 waters are dealt with under "Ministry of Agriculture and Fisheries." A sample of clay alleged to possess curative properties was examined as to its composition.

Ministry of Agriculture and Fisheries.

The samples examined for the Ministry of Agriculture and Fisheries may be classified as follows:—

(1) Imported dairy produce & margarine.
(2) Butter and margarine taken at factories.
(3) Sheep dips.
(4) Water and pollution of rivers.
(5) Sea water.
(6) Substances under the Fertilisers and Feeding Stuffs Act.
(7) Substances under the Merchandise Marks Act.
(8) Miscellaneous articles.

Samples included in some of these classes, for example, those taken from imported dairy produce by Customs officers at ports in Scotland and Northern Ireland, are examined for the Board of Agriculture for Scotland and the Government of Northern Ireland, but, these samples are included with the totals as set out above.

DETERGENT ACTION OF SOAPS.

By George Paul Vincent.

Extract of long paper in the *Journal of Physical Chemistry* (Cornell University).

The truest measure of the detergent action of soaps is obtained by actual washing tests. An approximation may be obtained by other methods. Chief among these may be listed the ability of the soap solution to suspend a solid material stably and to carry solid material through a filter paper.

If the particles of a solid are sufficiently small, soap solution will prevent them from settling; and most of these same particles, which are stably suspended, will pass

through the pores of a filter paper. The two methods should give comparative results.

It is not to be assumed that the particles which are too large to be suspended, or carried through filter paper, are not cleansed from fabrics and the skin by soap solution. There is no known means by which these larger particles of solid material can be fitted into a quantitative measurement of detergent action, but the smaller particles can be utilised in the manners described.

The convincing evidence, that detergent measurement by the stable suspension method gives dependable results, is found in the agreement of these results with those obtained in actual washing practice.

" Stabilised " material, as used throughout this paper, is that material in suspension, which does not settle when allowed to stand for a lon gperiod of time (arbitrarily 10 to 20 hours), and which will pass through the pores of a filter paper.

McBain, by using Spring's discovery that soap solutions will carry carbon black through filter paper, has worked out a quantitative method for measuring the detergent power of soaps. From his extensive studies, he finds that the amount of carbon black carried through filter paper increases with increasing soap concentration up to a definite maximum, and from that point decreases. This mamimum occurs at a soap concentration of 4.45 per cent. The conclusion is drawn, that a concentration of 4.45 per cent. is the most efficient concentration of soap to employ in the detergent process.

Fall undertook a study of the same problem some few years later. McBain's method was a bit erratic and at best was none too accurate. Fall succeeded in obtaining a means of measuring detergent action by a study of the extent of stabilisation of MnO_2 in soap solutions. His method was free from many of the disturbing factors encountered by McBain and was consequently subject to a smaller percentage error.

SUMMARY.

The general results of this investigation are as follows :—

1. Soap solutions will suspend solid material stably because the solid particles become charged by adsorption of negative ions from the solution. The existence of an optimum value of soap concentration for this stabilisatin is due to the fact that the positive ions are also adsorbed from the solution. The soap concentration in which the ions are adsrbed to the same extent will cause no stabilisation, and the concentration in which there is strong adsorption of the positive ion will give the optimum stabilisation.

2. The amount of solid material carried through filter paper by soap solutions should parallel the amount stably suspended. Therefore, McBain's and Fall's results should agree. They are found to do so when the carbon suspensions, used by McBain, are so treated that the non-stabilised carbon does not retard the passage of the stabilised material through the filter paper.

3. The optimum concentration of soap for the suspension of solids, 0.2-0.4 per cent., is more than sufficient for the emulsification of oils, this requiring 0.05-0.10 per cent.

4. A concentration of soap above that necessary to cause emulsification is not harmful, but is beneficial to emulsification.

5. Palm Oil, Olive Oil, Tallow, Commercial Green Arrow, and Commercial Silicated Green Arrow Soaps vary only to a limited extent in their emulsifying powers.

6. High temperatures are detrimental to emulsification, as well as to suspension. A temperature of 40° C. (104° F.), is recommended.

7. Alkaline salts aid emulsification. NH_4OH, Na_3PO_4, and NaOH are very efficient. Beneficial results are obtained when the emulsifying solution contains 1.2 per cent. NH_4OH, or .32 per cent. NaOH. NH_4OH is not detrimental when present in excess, whereas NaOH and its salts are.

8. Sodium silicate is not an emulsifying agent.

9. The importance of wetting as a factor has been studied. The reason for highly concentrated soap solutions possessing good detergent value is because such solutions are extremely efficient wetting and emulsifying agents.

10. The reason that sodium phosphate is of such value as a detergent for greases containing calcium oleate is due to its ability to form sodium soap from the calcium oleate present. This process disintegrates the grease; causes the sodium soap to become thoroughly incorporated in the grease; and removes the calcium oleate, which substance emulsifies water in oil and works in opposition to the coap. The wetting ability of the sodium phosphate is also a factor.

11. One specific transmission grease, manufactured by the Deyo Oil Co., was emulsified more efficiently per gram of de-

tergent, by NaOH than by Na_3PO_4. Cleansing would occur in the same order. The grease presumably contained some organic material, which formed soap with the compound added.

12. The possibilities of a detergent compound of 20 per cent. soap and 80 per cent. sodium silicate of the correct composition, have been shown to be worth considering. The effect of such a detergent upon water softening, content of free alkali, and upon the textile fibres has been discussed.

13. Sodium hydroxide is more efficient than sodium silicate, and sodium carbonate less so, in softening waters containing iron.

14. The reasons for the benefical effects obtained by adding sodium silicate to a bleaching solution are as follows :

First, the loss in strength of the solution is retarded, because the alkaline nature of the silicate forces back the reaction forming HClO. This compound is unstable and decomposes, and thereby weakens the bleaching solution.

Secondly, the cloth fibres are only slightly weakened because they are bleached less than if no silicate were present. The loss in fibre strength is proportional to the amount of bleaching, this is in turn proportional to the amount of HClO present, and, as stated above, the sodium silicate retards the formation of this substance. Also some SiO_2 is probably adsorbed which strengthens the fibres.

Thirdly, in the bleaching process some slightly yellow decomposition product is formed, which is rather difficult to wash out of the cloth. The presence of sodium silicate in the bleach facilitates the removal of this substance.

GENERAL NOTES.

SOUTH-EAST ENGLAND ELECTRICITY SCHEME.

Outline of Commissioners' Proposals.

The Central Electricity Board have issued the following explanatory note on the provisions of the South-East England Electricity Scheme, 1927, of which they report the receipt from the Electricity Commissioners :—

The Scheme deals with an area of about 8,828 square miles, covering the counties of London, Middlesex, Hertford, Essex, Kent, Surrey, Berkshire, Bucks., Bedfordshire, Cambridgeshire, Huntingdonshire and Suffolk. It stretches from Wisbech and Peterborough on the North to the South Coast and had a population at the last census of 11,392,561. The area is of importance not only because it includes the densely populated metropolitan area and many residential towns both in the suburbs and on the coast, but also because it embraces the industrial area on both banks of the Thames, the London docks, the potential coal fields in Kent and a considerable mileage of electrified suburban lines, tubes, etc., as well as wide strips of rural and agricultural territory. In drawing up the Scheme it has been necessary to bear in mind the large demands which may be made in the event of the further electrification of railways and the extension of the industrial area, and the effects of sudden fog in the London district.

At present there are 105 authorised undertakings in the area, including the London and Home Counties Joint Electricity Authority and eight power companies, owning, between them, 185 stations. The present consumption of electricity is about 11 units per head of population. It is estimated that this will increase to an average of 265 units in 1933-34, and 426 units in 1940-41.

Stations.

Under the proposals, 13 existing stations and the two new stations projected at Battersea and Chiswick will be selected and operated for the Board. (A list of the stations is given in Appendix II. to the Scheme.) A further 15 existing stations will come into the Scheme under temporary arrangements for varying periods.

It is contemplated that three of the selected stations will be extended between 1931 and 1938, and that three additional stations will be erected before 1940, one in the northern part of the area, another, probably, in the neighbourhood of London, and the third on a site not yet determined. Broadly speaking, the Scheme looks forward to the area being supplied, ultimately, by 18 capital stations, *i.e.*, 13 existing, the two already projected, and three new ones. It is probable that the stations bearing the main load for the area will be the riverside stations of Battersea, Barking, Chiswick and Deptford, and the new Brimsdown station.

Transmission System.

The stations will be inter-connected by a series of high-pressure main transmission lines which will be joined up to and sup-

plemented by a series of secondary transmission lines at a lower voltage, suitable for the purpose of supplying the various undertakings concerned with distribution. The transmission systems, both primary and secondary, are designed in a series of ring-mains, so that there will be alternative routes to points of supply, and consequently greater security against breakdown. Incidentally, the inter-connection of these stations will result in the release for revenue-earning purposes of about 245,175 kilowatts of plant now kept as spare, and representing about £3,700,000 of capital.

ESTIMATED SAVINGS : COST OF THE SCHEME.

The Commissioners have outlined a plan of working the selected stations, with the necessary estimates. These suggestions are, of course, tentative, since the practical working of the Scheme, including the fixing of tariffs, is the responsibility of the Board; but taking the figures as they stand, it is of interest to note that the Commissioners contemplate that the Board should be able to commence supplying in *August, 1928, and estimate that in the five* years 1929 to 1934 there will be a resultant saving to the undertakers in the area of nearly £5,000,000, or an average of about £1,000,000 per annum. There must be added a further saving due to the cessation of the capital charges on existing generating plant in stations which will be shut down. This extra saving will accrue as and when the capital cost of the discarded plant is redeemed. An indication of the extent of such further savings is afforded by the fact that the capital charges on plant in the stations which are expected to be shut down by 1933-34 amount to £480,000 per annum.

The cost of the Scheme to the Board for the erection of the Primary Transmission system is estimated at about £6,500,000. In addition, there will be an expenditure of about £5,500,000 by the owners of generating stations, on extensions, etc. It is estimated that the full advantages of the Scheme can be secured with a saving of about £500,000 on capital expenditure (up to the year 1933-34) as compared with the expenditure which would be necessary if the present system were continued. After this date the saving on capital expenditure would be progressively greater as compared with individual development.

BOARD OF TRADE ANNOUNCEMENT.

SAFEGUARDING OF KEY INDUSRIES.

The Board of Trade give notice that representations have been made to them under Section 10 (5) of the Finance Act, 1926, regarding lithium carbonate, lithium hydroxide and quinine ethyl carbonate.

Any person desiring to communicate with the Board of Trade with respect to the above-mentioned applications should do so by letter addressed to the Principal Assistant Secretary, Industries and Manufactures Department, Board of Trade, Great George Street, S.W.1., within one month from the date of this notice.

WHOLESALE PRICES IN SEPTEMBER.

BOARD OF TRADE INDEX NUMBER.

As measured at the Board of Trade, wholesale prices in September were, on the average, 0.8 per cent. higher than in August, the index numbers for the two months being 85.5 and 84.8 resepectively. (1924 = 100). Both foodstuffs and industrial *materials* became dearer, the former by 1.4 per cent., and the latter by 0.5 per cent. The most important changes in the group indices were in meat and fish which rose by 5.6 per cent. The last men*tioned rise was preceded by one of 4.9 per* cent., comparing the cotton index for August with that for July, and the September index of 78.0 is the highest for that gfoup since November, 1925. The indices for the other groups of commodities, comparing September with August, show a fall of 0.3 per cent, in cereals, of 0.8 per cent. in miscellaneous foods, of 1.0 per cent. in iron and steel, and of 1.1 per cent, in other metals and minerals, while for textile materials other than cotton and for miscellaneous industrial materials rises of 0.4 per cent. and 0.3 per cent. respectively are shown.

SCIENTIFIC AND INDUSTRIAL RESEARCH.

Sir William James Larke, K.B.E., has been appointed by Order of Council dated the 5th October, 1927, to be a member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

ROYAL INSTITUTION.

The Courses of Lectures at the Royal Institution during November and December will commence on Tuesday, November 1, *at 5.15 p.m., with the annual course of* three Tyndall Lectures which will be delivered by Sir John Herbert Parsons on the subject of Light and Sight. These will be followed on November 22, by four lectures by Sir William Bragg on a Year's Work in X-ray-crystal analysis. On Thursday afternoons beginning on November 3, there will be two lectures by Mr. H. Clifford Smith on the Furniture and Equipment of the Mediaeval House; three by Dr. R. E. Mortomer Wheeler on London before the Norman Conquest; and two by Mr. James Kewley on Petroleum Natural Gases and their Derivatives. The Saturday lectures will be given at three o'clock *starting on November 5, when Mr. Emile* Cammaerts will give two lectures on the Main Features of Modern English Literature, to be followed by three musically illustrated lectures by Mr. Gustav Holst on Samuel Wesley and Robert Pearsall, and two lectures by Dr. F. J. M. Stratton on Recent Developments in Astro-physics. The 102nd Course of Christmas lectures for Juveniles will be delivered by Professor E. N. da C. Andrade on " Engines " commencing on Thursday, December 29, at three o'clock. The subjects of the lectures will be (1) The Rules which all Engines must obey; (2) Learning about Steam; (3) Engines which work to and fro; (4) Engines which work round and round; (5) Putting the Furnace in the Cylinder; (6) Heat Engines which produce cold.

THE COAL INDUSTRY IN THE FIRST QUARTER OF 1927.

The publication of the Statistical Summary issued by the Mines Department for the first quarter of 1927 should do something to correct the wild statements that have been made as to the losses of the industry and the earnings of the miners since the resumption of work.

It is quite true that the period was still abnormal and that the same results cannot be expected from the second quarter of the year. But a comparison with the first quarter of 1926—when the subsidy was still being paid — yields the following very remarkable results :—

Per ton Commercially disposable	March Quarter 1926	March Quarter 1927.
	s. d.	s. d.
Net cost of production	17/2.05	16/1.92
Wages cost	12/3.88	11/1.85
Avge. earnings per shift	10/4.79	10/7.32
Credit or Debit Balance omitting Subsidy	Dr.1/4.63	Cr.1/2.41
Do. Aggregate	Dr.£4,186,849	Cr.£3,497,408

Surely those figures are an answer to the reckless and persistent charges of the complete failure of the Colliery Owners' policy.

Admitting the abnormality of the period admitting that the proceeds of commercial disposals rose from 15/9.42 per ton to 17/4.33, it still remains a fact that costs were reduced, that earnings per shift *actually increased, and that a loss of nearly* £4¼ million was turned into a credit of nearly £3½ million.

Proceedings and Notices of Societies.

THE INSTITUTE OF METALS.

Synopses of papers presented at the Annual Autumn Meeting, held in Derby, September 6 to 9, 1927.

The Under-Cooling of Some Aluminium Alloys. By MARIE L. V. GAYLER, D.Sc.

The effect of under-cooling on the macro- and microstructure of some silicon-aluminium and copper-aluminium alloys has been studied. It has been found impossible to under-cool " modified " silicon-aluminium alloys systematically, and it has been shown that the curves of solubility represented by the " modified " diagram correspond closely to the supersolubility curves of the " normal " alloys.

The Constitution of Alloys of Aluminium with Silicon and Iron. By A. G. C. GWYER, B.Sc., Ph.D., and H. W. L. PHILLIPS, B.A., A.I.C.

The first part of this investigation deals with the constitution of binary alloys of aluminium with silicon and with iron. The eutectiferous nature of the aluminium-silicon system has been confirmed, and special attention paid to the solubility of silicon in solid aluminium. The position of the Al-$FeAl_3$ eutectic has been redetermined, and the structure of the alloys lying towards the middle of the constitutional diagram has been, it is thought, elucidated.

The second part deals with the constitution of certain of the ternary alloys of aluminium, silicon ,and iron, under both equilibrium and metastable conditions. The latter are of considerable practical importance, because they are met with not only in commercial alloys, but also in commercially pure aluminium.

The Equilibrium Diagram of Copper-Tin Alloys Containing from 10 to 25 atomic per cent. of Tin. By A. R. RAPER, B.A.

This investigation on the copper-tin alloy forms a continuation of the work done by Stockdale on this system. The alloys have been examined both by thermal and micrographic analysis, and the results obtained have confirmed in many respects the classical work of Roberts-Austen and Heycock and Neville.

The $\alpha + \beta - \beta$ boundary has been carefully determined micrographically. This boundary shows a sudden change in direction at 580°, which together with other micrographic evidence favours Stockdale's view of a polymorphic change of the β constituent.

The eutectoid point has been found to be at Sn 16.15 (or 73.15 per cent. Cu by weight), the temperature of the inversion being 520°.

The " transformation " curve has been determined carefully by thermal analysis, and the results are entirely in agreement with those of Roberts-Austen and Stansfield. In particular, the slight horizontal indicated by them at about 610° has been confirmed. As determined by the present author, it exists from Sn 22.5 to Sn 25 at a temperature of 638°. The inclusion of this new horizontal in the diagram makes the interpretation of this region easier, and evidence for a new eutectiod at Sn 3 has been obtained.

Effect of Work and Annealing on the Lead-Tin Eutectic. By F. HARGREAVES, A.R.S.M., D.I.C., F.I.C.

A marked softening action of work at air temperature on the lead-tin eutectic is investigated. In the case of 78 per cent. reduction in thickness, the Brinell hardness is reduced from about 14 in the chill-cast condition to 4.2 when tested immediately after hammering. This value is actually lower than that of either constituent in the pure state. Annealing at air temperature and at 100° C. for different periods in hardness determined. Finally, the effect of annealing at just below the melting point is recorded. Little micrographic work is recorded. Reference is made to the relationship of well-known phenomena to the results obtained.

Researches on Intermetallic Compounds. VI.—The Reaction Between Solid Magnesium and Liquid Tin. By WILLIAM HUME-ROTHERY, M.A., Ph.D.

,,The reaction between solid magnesium and liquid tin has been studied between 250° C. and 350° C. in order to see whether reactions of the type

Primary solid X + liquid =
secondary solid Y

can proceed when the solid phases concerned do not form solid solutions.

When a rod of magnesium is stood in a limited quantity of molten tin, the magnesium dissolves until the liquid reaches the equilibrium composition at the particular temperature concerned. Since, however, true equilibrium requires the compound Mg_2Sn (probably Mg_4Sn_2) as the phase in equilibrium with the liquid, a further reaction of the type.

Solid magnesium + liquid
= solid magnesium stannide

tends to take place, and the above point can be tested, since no solid solutions are formed.

The experiments show that when sufficient magnesium has dissolved to give the liquid the equilibrium composition, all further direct reaction is stopped by a thin film of magnesium stannide which shows no appreciable thickening even after three weeks at the above temperatures. On the other hand, a few large crystals of magnesium stannide are sometimes formed by a slow reaction. This is probably the ordinary phenomenon of crystal growth due to surface energy and to tends to form a more ocmpact mass. But any solution at one point exposes more magnesium to the action of the liquid ,and so the reaction gradually proceeds.

The experiments are regarded as of interest in connection with the fundamental principles underlying soldering and other reactions between solid and liquid metals.

The Copper-Magnesium Alloys. Part II. By W. T. COOK, B.Sc., A.I.C., AND W. R. D. JONES, M.Sc.

This report deals with an investigation on the forging of copper-magnesium alloys, and is a continuation of that given on the casting of these alloys and the mechanical properties of chill-cast bars. The properties of the alloys in the forged and heat-treated conditions have been determined and examined. The ductility of these alloys depends primarily on the forging temperature. If this temperature be low the elongation and the reduction of area are impaired seriously,

and the values are not restored by subsequent heat-treatment. The mechanical properties of copper-magnesium alloys containing up to 11 per cent. copper are not improved by simple heat-treatment, which causes a general decrease in test values. The addition of copper to magnesium up to about 2 per cent. is beneficial. Beyond this amount the increase in tenacity is small, whilst there is a regular decrease in ductility and a proportional increase in specific gravity. There is no advantage in adding more than this amount of copper to magnesium either for castings or for forgings. To obtain the best results the forging temperature must be controlled, and care must be taken to guard against any possibility of cold-shut when casting ingots for forging.

Grain Growth in Compressed Metal Powder. By C. J. SMITHELLS, D.Sc., W. R. PITKIN, AND J. W. AVERY, B.Sc., D.I.C.

The changes which take place in certain properties of bars of pressed tungsten powder when the temperature is gradually raised have been investigated. These changes are attributed to grain growth, which is shown to begin at a temperature determined by the particle size of the powder and the pressure used in forming the bar. Using powders whose mean particle size varied from 0.6 to 3.5μ, and pressures between 8 and 32 tons/in^2, the temperature at which grain growth could first be detected varied from 1,100° K. to 1,500° K. These conditions cover those usually employed in the technical preparation of ductile tungsten. The results are in conflict with those of Sauerwald, who was unable to detect grain growth below 2,800° K., but are consistent with the established facts of grain growth in worked metals.

CORROSION BY OIL.

By HORACE P. YOUNG, F.I.C.

(Before the Institution of Petroleum Technologists, October 11, 1927.)

Severe corrosion having occurred on the pins and journals of the crankshafts of two motor ships it fell to the author to ascertain the cause and, if possible, to find a remedy.

Never before, in the author's experience has applied science been so able to demonstrate to the satisfaction of the practical engineer exactly how his troubles arose. This paper, therefore, is confined to a description of the work done and is presented in the belief that it will throw some new light upon corrosion by oil, and perhaps establish some improved methods of testing oils for corrosive properties.

It is vital to this paper to state that the oils, as taken from the lubrication systems of the ships, were fully examined by, at least, two competent and independent laboratories and were reported to be innocent of causing the corrosion. Moreover, the laboratories in question knew of the trouble which had occurred and their work was directed with that in view.

As the result, however of many hours spent on the engines concerned, the visual inspection of the working parts of those engines and the analysis of a large number of samples collected during that examination, the author was lead into a new train of thought from which arose directly and simply the solution of the mystery.

The position at that time was that corrosion had happened—corrosion of the most virulent and destructive type—in spite of which, tests of the oils gave no clue to the cause of the trouble. All other explanations being hypothetical and unacceptable to the author, he arrived at the conclusion that the analyses must be valueless and devised what he calls a Direct Oil-Corrosion test (for the sake of brevity, this test in future will be referred to as the D.O.C. test).

The test is performed by means of an apparatus whereby warm oil is run continuously over warm steel, white metal, brass, copper, or any other metal. The temperature employed by the author was 10° C. below the boiling point of water, but may be any temperature demanded in any particular case. In order to reproduce the conditions of the pins and journals, slabs were cut from similar steel and one-half of thei surfaces " white-metalled " with bearing metal of the same make and quality as tha used on the engines. It was possible, therefore, in one and the same test, to observ the effects of the oil upon the steel, the bear ing metal, and at the point where the tw materials met—as a matter of fact, ove many experiments, there has been n definite indication of increased activity a this junction.

The first test of this nature, when applie to the oils from the two motor ships, showe immediately that they were highly corr sive to both steel and white metal. Th aspect of the problem was nothing less tha astounding, the new position being follows :—

(1) The immense damage on these tw ships had been caused by the oils.

(2) The analysis of the oils had shown nothing.
(3) Direct means had been found of proving whether an oil is corrosive.
(4) Hence, it might well be possible to find a cure for the trouble.

In the case of oils from internal combustion engines of all types it would appear that the corrosive deterioration or the contamination is accumulative. For this reason the specimens from the D.O.C. test need to be examined under a microscope. This side of the work is yet in progress and little can be said beyond stating that it has been proved that many of such oils are corrosive, to a greater or lesser extent, to steel, white metal and so on. The gravity of this state of things, from a practical point of view, is evident. It may be true—in certain cases it certainly is true—to say that some of the effects ascribed to attrition are due directly or indirectly to corrosion by oil.

Analysis having failed to detect the properties of oils which D.O.C. tests proved to be highly corrosive, it appeared necessary to conduct a research upon an oil to which definite quantities of acid had been added. A lubricating oil giving negative results under the D.O.C. test was chosen.

It became evident from these tests that, so far as practice is concerned, alkali treatment is unsuccessful for the reason that the alkali and salts cannot be removed completely by washing. Other alkalies, such as carbonate of soda, were tried with similar results. If the efficient washing possible in a laboratory is insufficient it would appear hopeless to expect good results from such washing as can be done in practice. That we have been unable previously to demonstrate these happenings has been due, the author believes, to the failure of chemical analysis as applied to such work and the lack of a direct method as is the D.O.C. test.

Reverting to those oils which become corrosive in service, many samples have been subjected to the D.O.C. test and have been analysed by the sulphate value method (given in appendix) as previously applied to the " acidified " samples.

A sulphate value of more than 0.05 per cent. is an indication that the oil is dangerous to use.

Corrosive powers are active down to as little as 0.012 per cent. sulphate value. It should be noted that all these oils were tested for inorganic acid, the results showing either nothing at all or a trace too small to matter. A series of cleaning tests, somewhat similar to those described in the case of the " acidified " oils, were carried out on most of the above oils, many alkalies being tried together with other methods such as steam cleaning. Alkali treatment was unsuccessful by reason of the impossibility of complete washing, whilst steam cleaning was marred by the difficulty of emulsions being formed unexpectedly and sometimes considerable losses of oil occurred before separation could be effected.

Experiments have been made, using the D.O.C. apparatus, with a view to finding out if the corrosive properties of an oil became exhausted as the result of running it over steel. The results have proved most conclusively that the vitality of the sample remains unabated, and, after many hours' running, when the corroded piece of steel has been replaced by a fresh piece, the attack continues unaltered. Evidently the products of corrosion are as corrosive as the original corrodent—possibly in the case of an internal cmbustion engine there is at any time little difference between thme. In using the sulphate value it is essential to know also the results of a D.O.C. test, because experiments have been made by adding sulphates to uncorrosive oil and it was found that all sulphates are not equally corrosive under these conditions.

It will be remembered that in the case of the " acidified " oils some of the added sulphuric acid could not be extracted by caustic potash. Yet this " lost " acid was harmless to steel. This phenomenon gave rise to much doubt when considering the early experiments, and steps were taken to ascertain whether at any period sulphur gases were evolved from the sample such as might account for the apparent " loss " of sulphuric acid. No evolution of any gases whatsoever was detected.

SUMMARY.

By the D.O.C. test as little as 0.002 per cent. H_2SO_4 can be detected, and the test is equally sensitive to minute amounts of sea-water, alkalis, sulphates, and so on. The alkalis so readily affect white metal that an oil cleaned by alkali will attack white metal even when that oil has been washed three or four times with water.

The D.O.C. test thus affords a means of testing the efficiency of any cleaning process. In this connection it has led to the perfecting of a simple appliance which, inserted into an oil-system, will keep the oil " sweet."

The study of compound lubricants as used on compressors is greatly facilitated

and, at the time of writing, valuable information is being obtained as to the effects of high acid value (oleic), high saponification number, and so on.

In practice, the D.O.C. test is being used as a means of watching the oils on internal combustion engines for land or marine work, and within a few hours of receiving the sample it is possible to tell the owners whether their oil is becoming dangerous to use. In transport work — automobiles, lorries, motor 'buses—great interest has been shown in this matter, many oils being found to be corrisive. In another direction, an expert marine engineer has expressed the opinion that the D.O.C. test may throw light upon the pitting of the teeth of turbine gearing which sometimes takes place in a manner never satisfactorily explained.

Corrosion in pipe-lines is not unknown, and the work of discovering its progress, cure or prevention may be facilitated by this test.

SOCIETY OF PUBLIC ANALYSTS.

An Ordinary Meeting of the Society was held at the Chemical Society's Rooms, Burlington House, on Wednesday, October 5, Mr. E. Richards Bolton, President, being in the chair.

Certificates were read for the first time in favour of Messrs. Leslie V. Cocks, A.I.C., Frederick Dixon, B.Sc., A.I.C., David Michael Freeland, A.I.C., Desmond Geoghegan, Claudius George Hyde, A.R.C.S., F.I.C., Vernon James Tilley, F.I.C., Leonard Wild, B.Sc., Hugh A. Williams.

Certificates were read for the second time in favour of Messrs. Charles Edwin Corfield, B.Sc., F.I.C., Harold E. C. Powers, B.Sc., A.I.C., John David Rogers, and Abraham Samson, A.R.C.Sc., A.I.C.

The following were elected Members of the Society :—

Frederick Cecil Bullock, B.Sc., A.I.C., Thomas Harold Fairbrother, M.Sc., F.I.C., Ralph Skinner Rack, and Samuel George Sherman.

The President announced that the next meeting of the Society on November 2 would be held, by invitation of the Pathological Institution of St. Mary's Hospital, in the theatre of that Hospital.

The following papers were read and discussed :—

The Oil of Centrophorus Granulosus. By A. CHASTON CHAPMAN, F.I.C., F.R.S.

The liver oil of the Portuguese shark "barrose" (*Centrophorus Granulosus*) contains the unsaturated hydrocarbon, spinacene, an alcohol probably identical with the batyl alcohol found in Japanese shark oils, a liquid alcohol (selachyl alcohol, $C_{21}H_{40}O_3$), cholesterol and glycerol (0.5-0.6 per cent.), together with stearic, palmitic and oleic acid, and possibly smaller proportions of other saturated and unsaturated fatty acids.

The Separation of Titanium from Tantalum and Niobium. By W. R. SCHOELLER, Ph.D., AND E. C. DEERING, B.Sc.

Previous methods of separating titania from the earth acids are reviewed and criticised, and an outline is given of a more accurate separation method based on the dissociation of the soluble tartaric complexes of the metallic acids by a mineral acid; the earth acids are precipitated, whilst the titanic salt remains in solution. the results as yet obtained are rather approximate, but work aiming at a more exact separation is in progress.

The Determination of Aldose Sugars by Means of Chloramine-T, with Special Reference to the Analysis of Milk Products. By C. L. HINTON, F.I.C., AND T. MACARA, F.I.C.

Each molecule of chloramine-T is equivalent to two atoms of iodine, both in the oxidation of sugar and in the final liberation of iodine on acidifying. The oxidation proceeds more slowly than that with alkaline iodide solution. The most suitable conditions for the oxidation of dextrose and lactose have been worked out, and the extent of the slight oxidation of sucrose and lævulose under standard conditions has been determined. The action of chloramine-T on the non-sugar constituents of milk serum has been studied; under the conditions specified it does not cause an error greater than 0.4 per cent. of the total lactose. A procedure is outlined for the determination of lactose in fresh milk and condensed sweetened and unsweetened milk

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CORRESPONDENCE.

ARITHMETICAL RELATIONSHIP BETWEEN ZINC INDIUM AND COBALT.

(*To the Editor of the* CHEMICAL NEWS.)

Sir,

The title refers to the arithmetical relationship of the atomic weights and numbers representing these elements. The atomic weight of In. is 114.8; the atomic numbers of cobalt and zinc are 27 and 30. 114114..

- *0114114.. = 1027.*

6537/5897 x 2707 = 3000.

The natural numbers are 114... and 2707; the number containing the zero is termed the "proportion," and 114 is termed the "part." The extent of the recurrence of the three-figure part depends on the nature of the relationship. Whatever this may be, it can be always recalculated with 114... to the same number of places as the original number containing the part indicating the finality of the number. The resulting number should be of the same order as that containing the part, that is, there should be one or more zeros in the specified position, and 2707 directly or indirectly.

(1) The numbers 29686, 85462 are written out as one number, twice, and added diagonally four times. The sum is 29985711410101911 4,880166.. The number is stopped at the second 114. 85462/29686 × 114...1 (19 places) gives

1365472689598702707590. 29686-85462 × 114...1 gives 9536647357418247660 78; the zero is in the 19th position. 76607 - 49592 = 27075. Taking the 9 figure part the numbers are 9536647347876600 30 and 18654726882. In the former case 8766, the atomic weight of Sr. should count as one place; in the latter, the alternate figures form numbers which give a zero sum.

(2) 8546229636... gives the sum 85820501019114 (14 places) 29636/35462 × 114...11 = 953664785741290384. The zero is in the 15th position and the number cancels out. The reciprocal is 1865472636224007. The part in 2 is substituted for that in 1, and 29686, etc., subtracted. The result is 676'99999948 + 57; this number is the product of 114114114 and 59274000054279.

The figures up to the zero add horizontally to 71; 2707/710 × 35462/29636 = 4 × 114.

85820501019114 gives 36182824261780951808075 14 (seven additions).

73095/2 = 365475, compared with 3(861823) = 865477.

The same arithmetical operations with 114... gives 11526678193,844 829177662511 and 17216458888 12555. 3655 - 1722 = 1983. Adding the numbers as found in the numerical series 198344... + 172164... and subtracting to 3546... gives 354652987685, which is practically the original number, determined entirely from 114...11.

The proportion is a large number and the part should be employed, until it is equal on the system to a small fractional part of the proportion.

With this reservation, the following numerical relationship illustrates the *modus operandi* and the circumstances which give in the result reversed numbers, which are accurately related.

85.45 - 27.07 = 5838; 39.1 - 27.07 = 12.03.

(1) 12.03 × 27.07 = 325.6521.

(2) 325.6521 × 29.09/58.38 = 16.22682.

Sum of (1) and (2) is 48.79203 = 85.45 - 3665797.

The logarithm to the base 10 of 48.79203/85.45 is 7566370 which is the reversed 36657. Note that 3665797 × 4879203/8545 = 2093174.

Yours, etc.,

A. SAKOSCHANSKY.

DR. GEORGE K. BURGESS, DIRECTOR OF U.S.A. BUREAU OF STANDARDS, ANNOUNCES NEW GROUPING OF ACTIVITIES.

L. J. BRIGGS AND RAY M. HUDSON ASSISTANT DIRECTORS.

Am important change in the administrative organisation of the Bureau of Standards, which it is believed will make for increased efficiency through a better grouping of the Bureau's numerous activities, has been announced by the Director, Dr. George K. Burgess.

Under the new arrangement Dr. L. J. Briggs has been appointed Assistant Director in charge of research and testing, while Mr. Ray M. Hudson becomes Assistant Director in charge of commercial standards.

The regrouping is, in fact, a recognition of the importance of standardisation in the commercial world, this portion of the Bureau's work having grown with astonishing rapidity during the last few years.

FORTHCOMING EVENTS.

INSTITUTION OF ELECTRICAL ENGINEERS.

Monday, October 24, at 7 p.m.—Informal Meeting. The President: "What is Required to Ensure the Comprehensive Distribution of Electricity?"

Liverpool and North Wales Centre, at the University of Liverpool. — Prof. F. J. Teago, D.Sc.: Chairman's Address.

N.E. Centre, at Armstrong College, Newcastle-on-Tyne, at 7 p.m. — Chairman's Address.

Tuesday, October 25.—East Midland Sub-Centre, at the Guildhall, Derby,—A. E. McColl: "The Lanarkshire Hydro-Electric Scheme." At 6.45 p.m.

ROYAL INSTITUTE OF PUBLIC HEALTH.

37, Russell Square, London, W.C.1.

Wednesday, October 26, at 4 p.m.—Prof. T. G. Hobday, C.M.G., F.R.C.V.S., F.R.S.Ed.: "Some Diseases Conveyed to Man from Animals, and their Prevention."

UNIVERSITY COLLEGE.

Gower Street, London, W.C.1.

Thursday, October 27, at 5.30 p.m.—Rt. Hon. Viscount Cecil of Chelwood: The Rickman Godlee Lecture: "The Cooperation of Nations."

INSTITUTION OF MINING AND METALLURGY.

Cleveland House, 225, City Road, London.

Thursday, October 27.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Saturday, October 29, at 7 p.m.—Chemical Section.

PHYSICAL SOCIETY.

Saturday, October 29, at 5 p.m.—At Imperial College of Science, Imperial Institute, S. Kensington, London.

NOTICES OF BOOKS.

Theoretical and Experimental Physical Chemistry. By James Codrington Crocker, M.A. (Cantab.), D.Sc., (Lond.), F.I.C., and Frank Matthews, Ph.D. (Lond.), B.Sc., F.I.C. Pp. VIII + 582, with 145 figures in text. Price 21s. London: J. & A. Churchill, 7, Great Marlborough Street, London, W.1.

This is a valuable work, not only for the important matters with which it deals, but also from the fact that it is the outcome of some 25 years' experience in teaching physical chemistry, and we might add the competence of the authors. They have sought, and we think, successfully, to include in one volume the varied information necessary in reading for the Honours Degree Examination, and for which the student has invariably to study several volumes. Theory and practice have been closely observed by the authors. There are sections on gases, spectra and atomic weights, ultra-violet absorption spectra, X-ray spectra, etc. Colloids, chemical energetics, catalysis are dealt with in special chapters. The authors have had the cooperation of many competent persons and firms, and the result is the production of a book calculated to meet the wants of students preparing for examinations of various kinds and one which can be read with advantage by others interested in physical chemistry as well as students.

U.S.A. OFFICIAL PUBLICATIONS RECEIVED

Department of the Interior.

Mineral Industry of Alaska in 1925, and Administrative Report. By Fred H. Moffit.

Quality of Water in Colorado River in 1925 and 1926.

Manganese-Bearing Deposits near Lake Crescent, Washington.

Geology of the Knik-Matanuska District Alaska.

Surface Water Supply of the U.S.A., 1923 (W. Gulf of Mexico Basins)—Part III. *Ohio River Basin.*

Organic Precipitate of Metallic Copper.

Potash Brines in the Great Salt Lake Desert, Utah.

Leadville Mining District, Colorado. By S. F. Emmons, J. D. Irving, and G. A. Loughlin. Pp. 368, accompanied by numerous plates.

Department of Agriculture.

Grouping of Soils on the Basis of Mechanical Analysis. Dept. Circular 419.

CANADIAN PUBLICATIONS.

Department of Mines.

Preliminary Report on the Limestones of Quebec and Ontario. By M. F. Goudge. Pp. 76. Price 25 cents.

Abrasives—Siliceous, Sandstones, Quartz, Tripoli, and Volcanic Dust. By V. L. Eardley Wilmot. Pp. 120. Price 30 cents.

Use of Alberta Bituminous Sands for Surfacing of Highways. By S. C. Ells. Pp. 88. Price 25 cents.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

25,784.—Beckett, E. G.—Production of benzoic acid, etc. September 29th.

25,948.—Maclaurin, A. M.—Means for installing drain pipes. September 29th.

25,420.—Suida, H.—Recovery of concentrated acetic acid. September 26th.

25,586.—Kloepfer, H. — Production of alkali hydrides. September 28th.

Specifications Published.

277,769.—Wlein, C. A.— and Brown, R. S. Utilisation of waste acid liquors in chemical processes.

260,577.—Mannich, C.—Process for the manufacture of cyclotrimethylene-arylpyrazolones.

266,744.—I. G. Farbenindustrie Akt.-Ges. —Treatment of crude nitrate of soda.

262,090. Procedes Tocco & Landi.—Production of synthetic ammonia.

272,842. Procedes Tocco & Landi.—Process for the production of ammonia.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

VANBEENOL.

482,469.—Chemical substance prepared for use in medicine and pharmacy.—*W. J. Bush & Company, Limited*, 28, Ash Grove, Hackney, London, E.8. October 5th.

SOLORIENS BRAND.

483,757.—Chemical substances prepared for use in medicine and pharmacy.—H. R. Napp, Limited, 3 and 4, Clement's Inn, Kingsway, London, W.C.2. October 5th.

COMITAS BRAND.

483,758.—Chemical substances prepared for use in medicine and pharmacy.—H. R. Napp, Limited, 3 and 4, Clement's Inn, Kingsway, London, W.C.2. October 5th.

VANBEENOL.

482,468.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—W. J. Bush & Company, Limited, 28, Ash Grove, Hackney, London, E.8. October 5th.

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This large volume contains a detailed Index to the first 100 volumes of the *Chemical News*, and will be found of great value to all interested in Chemical, Engineering, Electrical and General Scientific subjects. It has been compiled with great care, is handsomely bound in red cloth, and has been produced at great expenditure of time, labour and money. Carriage paid, Great Britain, 21/- net; Carriage paid to Foreign Countries and the Colonies, 23/- net.

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AGRICULTURE AND NATIONAL EDUCATION.

By C. G. T. MORISON, M.A., President of the Agriculture Section.

(*Before the British Association for the Advancement of Science.*)

When the Council of this Association did me the honour to invite me to become the President of the Agricultural Section for this year, I was filled with some consternation and alarm, as I recalled the long line of distinguished men who have filled this position in previous years and the high standard and excellence of their addresses. One of the difficulties that I felt most strongly was that, like many of my predecessors, I was originally a chemist who had fallen under the spell of agriculture, and whose fancy had led him, in the intervals of an otherwise busy life, to work at problems of the soil. Now, engrossing as those problems are, and fundamentally important to the business of agriculture as the results of such investigations can be, I observe that no one, at any rate in the last ten years, who has been President of this section has been brave enough to discuss them in his Presidential Address. The reason of this is perhaps not far to seek. There was a period in the history of agricultural science when chemistry seemed to offer all that was needed for a successful soil study, and when the chemists of the time appeared as the magicians of the piece, at the touch of whose magic wand all secrets were laid bare. Then with increasing knowledge, my colleagues fell under a cloud and a host of other scientists began each to play his part, and to add each his fragment to our simple theme, until, at the beginning of this century, there was collected so vast a body of data about the soils of the world that any orderly thinking about the subject became almost impossible. Order is, however, coming again, and coming once more at the hands of chemists, and before many years are past, perhaps one of my successors may be bold enough to try to present our knowledge of soil conditions to this audience in a suitable form. It is a task, however, for the future and not for to-day. What then was there left about which a soil chemist might venture to speak? It has been my fortune to spend most of my life at one of the old Universities, where, like many people at Oxford, much of my time and energy has been devoted to teaching, and it is because of the experienee that I have had in teaching agricultural subjects and in organising agricultural curricula, and of my great interest and belief in agricultural education, that I venture to make it the subject of my address to-day.

It is not so very long ago that research and education in agriculture began to be seriously developed in this country, first, on a physical basis which is, and must remain, fundamental, dealing with the technique of manufacture and with the elimination of waste in the manufacturing process; second, from the business side, so that the producer may have his business carried out successfully and at a profit. From the point of view of vocational training these two aspects are so closely interwoven that any attempt to magnify one at the expense of the other can only lead to disaster, whereas from the purely educational point

of view the two are quite distinct, and are better treated as stages in development, leading up gradually from the purely scientific subject of the growth of the plant and animal, through the application of this science to practical requirements, to the business organisation of the fundamental producing units.

The objects of vocational education in Agriculture have been recently described by Sir Daniel Hall, and further by Mr. Dale in his paper to this section last year, and may be summarised as improvement of farming technique by making the results of recent research more readily and more rapidly available, and improvement in business management resulting from more intimate knowledge of the economic details of the particular farming business and a wider acquaintance with the economic position of the whole industry.

The development of technical education in this country has had for one of its aims the improvement of farming methods by creating a class of farmers who have had the benefit of a training at either a Farm Institute, an Agricultural College, or a University, according as he could spare time and money to pursue his studies. At the conclusion of these studies the presumption is that he will spread the light of his knowledge and his skill in his neighbourhood and, by the strong force of his example, cause an improvement in the methods of his neighbours. Thus would the country benefit from the greater yields per acre which would be grown, and the farmers themselves from their more satisfactory economic position.

Unfortunately for the industry things do not work out quite so simply. The number of those who, on leaving the Universities and Colleges, engage in farming and set the shining example I have mentioned are none too many, and the effect in this way upon farming practice has not been as great as might have been expected. The great landlords, too, with certain notable exceptions, have hardly lived up to their eighteenth-century tradition in taking the place which is theirs naturally as leaders of the countryside in agricultural and farming affairs. Even the country clergy, who seem in the eighteenth century to have been knowledgeable in these matters, have apparently lost heart. Thus it appears that, despite all the money which is annually spent on higher education, there is not going forth into the countryside from our Universities and Colleges that stream of well-informed and well-educated young men and young women whose influence would so greatly modify farming practice up and down the land. For let us be quite candid about the situation: British farming at its best as it is carried out by certain individuals and in certain districts—and that there is a greater concentration of these individuals in some districts no one will deny—is second to none all the world over. There are, however, a large number of farmers whose technique is poor, whose methods are slovenly, and whose general standard falls very far below that of the best. I cannot but believe that even in the pre sent difficult and harassing economic situation their position would be better were their standards somewhat higher, and their aim to increase rather than decrease their output.

The improvement in farming technique has been sought by the methods described by Mr. Dale, which consist in affording in all parts of the country access to three types of education, provided by means of University departments and Colleges, by Farm Institutes, and by local classes and lectures. Each of these types has a separate function in the whole scheme and, while the part played by local classes and by the Farm Institutes seems clear enough, the policy of the Colleges and the Universities is often rather vague and indefinite. If it is possible to make a criticism against these bodies in the last years it is this, that, while they one and all would, I imagine, claim that their function was to train their students in the technique of the agricultural business, so that as managers and occupiers of land, land agents, teachers, experts or officials, they could raise the standard and status of the industry, they appear to think that the different educational requirements of these various classes can be obtained under the same general scheme of instruction. There are, of course, great difficulties in the way of any one of these institutes definitely adopting a course designed to give the maximum benefit to any one of those classes which I have enumerated, but I think that in some cases at any rate the beaten track has been preferred, and the old methods have been considered good enough to suit conditions that have largely altered. I am convinced that only by taking careful stock of the whole situation, and by being perfectly clear about the result aimed at, can the money which is to-day expended

upon agricultural education have the desired effect.

It was pointed out by Mr. Dale in the paper already referred to that, if the case of wage-earners be excluded, the facilities in Universities, Colleges, and Farm Institutes were equal to the demands made, but that if these demands were as great as they should be, then the existing institutions would be overwhelmed. According to Mr. Dale's figures, the Colleges are only two-thirds full, and of this number only one-third are the sons and daughters of farmers. Something is wrong here, and until this is put right, excellent as is the work done by these institutions, it has not the effect upon industry in this country which its excellence deserves. No doubt a fairly large proportion of these students learning agriculture will have some influence upon the industry in the future, but it is within my own knowledge that there a considerable number of agricultural students in a University such as Oxford whose connection with agriculture subsequent to their leaving the University is very slight. I do not propose to traverse here already well-trodden ground in attempting to explain why there is not a greater demand for technical training in times of stress like the present. I believe that, while many factors contribute, it is mainly an economic question, and that the ordinary tenant-farmer is to-day in a position in which he can ill afford to spend money, even were he sufficiently farseeing to realise the ultimate benefit that would result. Such then is the main direction in which it appears to me that improvement in higher education is required, and this improvement must be achieved by a greater vision and clearer purpose on the part of these institutions, and by a greater apppreciation on the part of those whom they are designed to serve.

So far this scheme of vocational training only the actual farmers has been considered; nothing has been done to meet the needs of the manual labourer, and not very much to give the landlord a training suitable to his position as one of the partners in the industry.

The case of the manual worker is one of most urgent need; little or nothing is done to give him or her any kind of vocational training, and this in spite of the fact that the whole position of the industry at the present time, more than ever before, depends upon the efficiency of the labour unit. This aspect of agricultural education was dealt with by Mr. Duncan both at the Oxford Meeting and subsequently in an article contributed to the *Scottish Journal of Agriculture*, and it appears from this that no educational effort is being made to make the manual worker more efficient or to enable him to increase the value of his output. Mr. Orwin has recently stated that the lad who remains on farm work definitely occupies a lower social position than those of his own age and district who seek the more highly remunerated work that can be obtained in the towns. Wireless and the motor-'bus have done much to enliven rural conditions, but they really only succeed in emphasising the superficial undesirability of country life; country wages, and a country outlook. As Mr. Duncan has pointed out, until wages are higher, and until the skill of the worker enables him to earn those higher wages, agriculture will always be left with the more inefficient and the less active-minded of the countryside. The difficulties in the way of rendering labour more efficient are very great; the tasks to be carried out are so various, the possibilities of the use of machinery so limited, and the effective overseeing, which is responsible for much of the success in other industries, is almost impossible. The comparative failure of agricultural trade unions means that there is not the continual pressure for improvement that there is elsewhere. If labour became more efficient the result would be either that the same amount of work could be done in the same time by a smaller number of men, or a larger amount of work done in the same time by the same or a smaller number of men.

Now extensive agriculture in the newe countries is characterised by a large pro duction per man engaged in the work, whil in more intensive agriculture in the mor settled countries a lower production pe man is obtained, although the productio per acre may be more than double. Th urgent practical problem is to increase pro duction per man while at the same tim maintaining or increasing production pe acre. All this implies technical skill of r mean order on the part not only of th manager but also of the manual worke and to my mind it requires somethir more, something which makes the acquiri of technical skill a comparatively ea matter, and that something consists in good general and continued cultural educ tion. There is no doubt, I think, th education, cultural education apart fro

vocational training, is held in greater respects in all those parts of the British Isles which are not English. It is certainly true of Ireland and of Scotland, and, I understand, of Wales. England alone stands unconvinced. It is of course difficult to measure the extent to which general education contributes to mental alertness in later years, but there is often among farmers, and among the rural population generally, a certain lack of elasticity, a certain dullness of outlook, which will have to disappear if agriculture is to take its rightful place among the other great industries of the country. The skilled manager, the skilled man, the educated manager, the educated man—if it pays to employ these, and it does appear to do in other industries, then much more should be remunerative in agriculture, where the calls on the management are so multifarious, the task so difficult, and the skill demanded of the manual worker so very varied.

Let us now examine how a development of this kind affects the three partners in the agricultural business as we know it to-day—the landlord, the farmer, and the manual worker.

(To be Continued Next Week.)

SCIENTIFIC TREATMENT OF COAL.

IMPORTANT NEW CONTRACT.

By A WELL-KNOWN ENGINEER.

It is now becoming obvious beyond doubt, even to the non-technical man, that scientific methods will have to be adopted in Great Britain in connection with coal. The trend of events is illustrated in significant fashion by an agreement that has just been signed in the United States between the Public Service Electric and Gas Co., of New Jersey, and International Combustion Engineering Corporation, New York, to put down a low temperature carbonisation plant which will be much the largest in the world. This is to be commenced at once and consists of 8 "K.S.G." (Kohlenscheidungs-Gesellschaft) process retorts each with a throughput of 80 tons of coal per day, that is 640 tons for the complete installation. The output will include 2,500,000 to 3,000,000 cubic feet of very rich gas per day, 800 B.Th.U. per cubic foot, and is to be mixed with carburetted water gas to bring up the total to 4,000,000 cubic feet of towns gas, 580 B.Th.U. per cubic foot, while there is also to be provided a very large carburetted water gas plant, using raw coal, capable of giving in an emergency 3,000,000 cubic feet of gas per day.

The whole equipment is to be on the latest principles, and the 8 retorts will also turn out 450 tons of smokeless fuel a day (10-12 per cent. volatile matter) and 14,000 gallons of low temperature oils, that is just over 20 gallons per ton, of which about 50 per cent. is available for Diesel engines.

The Public Service Electric and Gas Co., is one of the largest firms in the United States and already has in operation gas plants turning out on the average 80,000,000 cubic feet of gas a day with a maximum capacity of 110,000,000 cubic feet.

Also, the "K.S.G." is a well-known process of low temperature carbonisation controlled by the International Combustion Engineering Corporation, of "Lopulco" pulverised fuel fame, who also own the "McEwen-Runge" process of the low temperature carbonisation of pulverised coal, the invention of McEwen, of London. In the "K.S.G." process, long horizontal, rotary cylinderical retorts of steel plate are used, externally heated to a maximum temperature of about 950° F. (510° C.), and a plant has been operated for several years at the Matthias Stinnes I/II Colliery, Karnap, near Essen. The process is handled in Great Britain, along with the "McEwen-Runge" process, by Coal Oil Extraction, Ltd., an associated company, of which S. McEwen, of London, is managing director, and having also on its board directors of International Combustion Ltd., and Messrs. Brunner Mond and Co., Ltd.

THE NERNST EQUATION II: THE IONISATION OF SODIUM ACETATE.

By MARTIN MEYER.

(Brooklyn Laboratories, The College of New York.)

It can easily be shown that the concentration of hydroxyl or hydrogen ion in a solution of a weak base or acid which has been exactly half neutralised by a strong acid or base should be numerically equal to the ionisation constant of the substance. This is obviously true in this simple form, only of a 1 : 1 acid or base. Since the salt formed is not completel yionised this relationship will even then be only approxi-

mately true, and it occurred to the writer that it might be employed as a means of determining the degree of ionisation of salts.

For acetic acid we have:

$$HC_2H_3O_2 \rightleftarrows H' + C_2H_3O_2^-$$

The ionisation constant expression may be written thus:

$$\frac{C_{C_2H_3O_2}}{C_{HC_2H_3O_2}} = \frac{K_{HC_2H_3O_2}}{C_{H^+}}$$

Now if the acetic acid in the solution has been exactly half neutralised by sodium hydroxide, practically all of the acetate ion wil come from the ionisation of the sodium acetate; the sight ionisation of acetic acid is further repressed and the total concentration of sodium acetate will be the same, approximately as the concentration of ionised acetic acid.

Hence:

Degree of ionisation of $NaC_2H_3O_2$ =

$$\frac{C_{C_2H_3O_2^-}}{C_{NaC_2H_3O_2} \text{ total}}$$

$$\frac{C_{C_2H_3O_2^-}}{C_{HC_2H_3O_2}} = \frac{K_{HC_2H_3O_2}}{C_{H^+}}$$

A solution of acetic acid was made up and titrated against sodium hydroxide. At neutrality to phenolphthalein a volume of acetic acid exactly equal to that just used was added and the resulting solution was carefully diluted to various concentrations. The concentration of acetic acid was then checked by titration against standard potassium hydroxide using phenolphthalein as an indicator.

The hydrogen ion concentration of the various solutions was then measured using a Leeds and Northrup potentiometer and the usual set-up of apparatus. Hydrogen ion concentrations were then calculated from the Nernst Equation:

$$\text{E.M.F.} = 0.0002\ T\ P_{H^+} + 0.280.$$

A normal calomel electrode was used and the temperature was 25° C.

C HAc	E.M.F. obs.	E.M.F. cor.	C H+ × 10⁻⁵	$\frac{1.85 \times 10^{-5}}{C_{H^+}}$	a (2) $NaC_2H_3O_2$	K $HC_2H_3O_2$ from a
.0936	.5492	.2692	3.04	.608	.779	2.37 × 10^{-5}
.1872	.5480	.2680	3.19	.581	.726	2.31 ,,
.4679	.5481	.2681	3.17	.583	.628	1.99 ,,
.9358	.5503	.2703	2.92	.634	.526	1.53 ,,
1.872	.5595	.2795	2.04	.905	.382	.77 ,,
2.246	.5601	.2801	1.99	.926	.359(?)	.72 ,,

(2) Degree of ionisation taken from Fales, *Inorganic Qualitative Analysis*, page 109.

Fales, in the reference just given, cites the results of G. S. Walpole (3) who determined hydrogen ion concentrations in buffer salt solutions. His result at 0.1 normal solution leads to the ratio $\frac{K}{2.37 \times 10^{-5}}$ = 0.780, which is the accepted value very closely.

It is possible that the absolute value of these results may be wrong by as much as 5 per cent., but their relative accuracy is far greater. The values of the degree of ionisation obtained in this way plotted against the concentration of the solutions yield a very interesting curve. This gives a very simple method of measuring the degree of ionisation of the salts of weak acids or bases for which the ionisation constant is known with high precision. It is also evident that what is really being measured is the activity coefficient, and this is strongly emphasised in the case of more concentrated solutions. It is further evident from these experiments that the value of the concentration of hydrogen ion obtained from the Nernst Equation is too highly in error in solutions stronger than 0.1 normal for many of the uses to which it is put. The writer has also established this fact in other unpublished work.

(3) G. S. Walpole, *J.C.S.*, 1914, cv, 2509.

WAVE-LENGTH MEASUREMENTS IN THE ARC SPECTRUM OF SCANDIUM.

By WILLIAM F. MEGGERS.

(*U.S.A .Bureau of Standards, May,* 1927.)

ABSTRACT.

The wave lengths corresponding to approximately 700 lines photographed in the 220-volt arc spectrum of scandium were measured relative to secondary standards in the iron spectrum. These values extend from 2540.87 in the ultra-violet to 8644.48 A in the infra-red; the majority are lines characteristic of neutral scandium atoms, a considerable number of lines originate with *singly ionised, and a few with doubly* ionised, atoms. Bands characteristic of scandium oxide molecules appear very prominently in the longer wave portions of the spectrum.

Since 1914 the spectroscopy section of this bureau ras followed a program of standard wave-length determination and spectroscopic analysis, the main object of which has been to describe what may be called the standard spectra of each of the pure chemical elements. The descriptions which have been available heretofore have often been of a qualitative character and sometimes lamentably incomplete, notwithstanding the great importance of more precise data for certain optical measurements, for the spectrochemical identification of the elements, and for the study of atomic structure and the mechanism of radiation. Since other investigators have also been engaged in improving these descriptions of spectra, our efforts in the past have been confined for the most part to the region of longer waves which has been almost entirely neglected by others. The application of photographic sensitizers to these spectroscopic investigations has resulted in extending the descriptions of the arc emission spectra of many of the chemical elements in the red and adjacent infra-red regions. Such data have already been published for lithium ,sodium, potassium, rubidium, caesium, copper, strontium, calcium, barium, magnesium (1), iron, cobalt, nickel (2), neon (3), krypton, xenon (4), titanium, vanadium, chromium, manganese, molybdenum, tungsten, uranium (5) silver, aluminium, gold, bismuth, cadmium, mercury, lead, antimony, tin, zinc (6), yttrium, lanthanum, cerium (7) neodymium, samarium (8), gadolinium, dysprosium (9), ruthenium, rhodium, palladium, osmium, iridium, platinum (10), and zirconium (11). For the last-named element the spectra were investigated throughout the entire range of wave lengths accessible with our grating spectrographs (2200 to 9500 A), and the same statement can now be made for scandium. The long wave portion of the arc spectrum of scandium was photographed and measured in this laboratory in 1923, at which time ,since no spectra of this element had ever been measured in the new international scale of wave-lengths, it was decided to extend the observations through the visible and ultra-violet regions. This work has been completed, and the purpose of the present paper is to present the results of wave-length measurements in the arc spectrum of scandium from the ultra-violet at 2300 A to the infra-red near 9000 A.

EXPERIMENTAL.

Scandium (Sc = 45.1; Z = 21) has long been regarded by most chemists as one of the so-called "rare earth" family of elements, and it still remains one of these in the sense that it is very scarce and extremely difficult to obtain in purified form. The present observations were made with 1 g of scandium ammonium oxalate carefully purified by Auer von Welsbach and acquired as a part of a collection of chemicals and spectrograms purchased from Prof. J. M. Eder, of Vienna, in 1920, when he discontinued his spectroscopic researches.

For the excitation of the characteristic spectra of scandium, the material was used on electrodes of copper or of silver between which an electric arc of 4 to 6 amperes direct current was produced with a potential difference of 220 volts. Exposures were made with both kinds of electrodes throughout the entire spectral range to eliminate the possibility of overlooking Sc lines which might be masked by lines either of Cu or of Ag.

As pointed out in connection with wave-length measurements in arc spectra of certain metals of the Pd and Pt triads (12), the use of arc electrodes of Cu or Ag for the excitation of spectra of pure salts, metal sponges, etc., is especially convenient when the arc-stream colour of the applied material is different from that of the metal electrodes. Silver and copper arcs both give an intense yellow-green flame, but scandium, on account of strong emission lines and bands in the red portion of the spectrum, imparts a very decided reddish tinge to the flame when it is carrying an effective part of the

current. When the red disappears and only yellow green remains, it is an indication that no appreciable amount of scandium is being vaporised in the arc.

The wave lengths were derived from diffraction grating spectrograms, the arc spectrum of iron being either superposed or juxtaposed to supply the standard wave lengths from which the values for scandium lines were derived by interpolation. A blank spectrogram of the Cu or Ag electrodes was usually photographed on the same plate to avoid the necessity of measuring and subsequently eliminating the Cu or Ag spectra.

Two diffraction gratings, each 640 cm radium curvature, were alternately used in making the spectrograms. They were used in parallel light in the mounting described in earlier papers (13). For the red and infra-red regious a 6-inch grating ruled by Anderson with 7,500 lines per inch, giving a scale of 10 A per mm., was employed, while the remainder of the spectrum was recorded with a similar grating, ruled by Rowland, with 20,000 lines per inch, which gave a dispersion of about 3.6 A per mm in the first-order spectrum.

Photographic plates procured from Schleussner, of Frankfurt a. M., were used for all the exposures because they had sensitive emulsions coated on long strips of extra-thin glass (6 by 40 cm and less than 0.1 cm. thick) which permitted bending them to fit the focal curve of the spectrograph. Three Sc exposures made by Eder on similar plates were found in the collection of spectrograms which he consigned to us .These extended over the interval 5500 to 6800 A; they were measured and averaged with the results of our own spectrograms.

The observations extended in the ultraviolet to 2250 A but no scandium lines shorter than 2540 A were photographed. For photographing the yellow and red portions of spectra the plates were bathed in solutions of pinaverdol and pinacyanol, and for recording the infra-red sensitising solutions of dicyanin were employed. The line of greatest wave length thus recorded with exposures of one hour duration was 8644 A. Very recently an attempt was made to photograph still longer waves of scandium with a neocyanin-bathed plate, but no new lines were found. This may, however, be attributed to excessive economy of exposure and of scandium, since the amount of material available had by that time dwindled to almost nothing.

RESULTS.

Descriptions of scandium spectra in limited wave-length intervals have been made by various observers. The most reliable ones up to the year 1911 are quoted by Kayser in Volume VI of his *Handbuch der Spectroscopie*; they are by Lockyer and Baxandall (14) (arc spectrum from 3907.62 to 5717.54 A), by Fowler (15) (arc spectrum 3933.55 to 6558.28 A), by Exner and Haschek (16) (arc spectrum 2438.74 to 6604.88, and spark spectrum 2238.03 to 6604.90 A), and by Eder and Valenta (17) (arc spectrum 5514.46 to 6835.20 A). Reproductions of the spectra and additional lists of the stronger lines appeared in the *Atlas Typischer Spektren*, published by Eder and Valenta, in 1911. They give three tables of wave lengths which contrain 184 lines measured in the arc spectrum (3251.48 to 6835.80 A), 180 lines observed in the spark spectrum (3249.59 to 6835.80 A), and 65 heads of bands in the scandium oxide spectrum (4672.85 to 6700.64 A). All of the above-mentioned measurements of scandium spectra were based on Rowland's system of standard wave lengths.

More recently, lists of wave lengths from the scandium arc were published by Crookes (18) and by Piña de Rubies (19). The first contains 101 lines (2420.025 to 6305.7 A), and the second 185 lines (2282.0 to 8394.2 A). Both are of doubtful value, because the measurements were made from relatively small-scale prism spectrograms and the results are very sketchy and qualitative.

In the Schumann region observations by Ireton (20) describe 45 lines in the spark spectrum of scandium (507.0 to 2238.7 A). Smith (21) has supplemented these for the purpose of analysing the structure of the Sc III spectrum by measuring several lines (780.60 to 2012.95 A).

Three other investigations, which are of inestimable value as descriptions of scandium spectra, must be mentioned, although they contribute nothing to the wave-length data. They are (*a*) the electric furnace spectrum of scandium as reported by King (22), (*b*) magnetic resolutions in the scandium spectrum by Goudsmit, van der Mark, and Zeeman (23) and (*c*) the absorption spectrum of scandium as described by Gieseler and Grotrian (24). King's observations extend from 3015.50 to 6558.28 A, the arc intensity, and furnace intensities at low, medium, and high temperatures being given for nearly 300 lines. In the second investigation mentioned the Zeeman effects for 80

scandium lines were determined. These identify the spectral terms which combine to produce the radiations, and are in perfect accord with the analyses of scandium spectra as reported by Russell and Meggers 2(5). Twenty-four scandium lines (3255.81 to 6418.57 A) were found by Gieseler and Grotrian to be absorbed in scandium vapor at 2000°C.; these observations, in connection with the Zeeman effects just mentioned, firmly establish the fact that the normal state of the scandium atom is described by a doublet-D spectroscopic term.

The results of our measurements of approximately 700 wave lengths in the arc spectrum of scandium are presented in Table 1. Wave lengths under standard observing conditions appear in the first column, our intensity estimates and notes in the second, King's arc intensities and temperature classes in the third, and vacuum wave numbers in the last. The probable errors of the wave lengths obtained with the larger scale grating—that is, shorter than 6,000 A—are rarely greater than 0.01 A except for faint lines which were observed only once. In the red and infra-red, for which the scale of the spectrograms was nearly three times as compressed, the errors are naturally larger; they probably average between 0.02 and 0.03 A. This applies especially to heads of bands, the effective wave lengths of which, on account of their unsymmetrical character varied considerably with the strength of the exposure. In making intensity estimates we have attempted to make finer gradations than are possible with the 1-10 scale which most spectroscopists use. The ratio of the weakest to the strongest lines was assumed to be 1 to 100, and lines of intermediate intensity were assigned intensities proportional to their estimated strength on this scale, except that a fe wvery weak lines observed only on the strongest exposure are marked " 0." Our relative intensities over restricted wave-length intervals appear to be roughly proportional to King's values, but the ratio of the two sets of estimates varies somewhat from one portion of the spectrum to another, probably on account of differences in the spectrographs, exposures, and photographic plates.

A suggested chemical symbol accompanies the intensity estimate when there is a possibility that a part of the line may be assigned to an impurity.

No attempt has as yet been made to interpret the band spectra of scandium compounds, but the line spectra have been very satisfactorily analysed and interpreted. The latter are dealt with by Russell and Meggers in a forthcoming Bureau of Standards Scientific Paper.

Proceedings and Notices of Societies.

THE CHEMICAL SOCIETY.

October 20, 1927.

Studies of Dynamic Isomerism. Neutral Salt Action in Mutarotation. By T. M. Lowry and G. F. Smith.

Although the mutarotation of glucose is catalysed by acids and bases, as well as by water, it is not affected appreciably by neutral salts of the type of sodium chloride.

Definite catalytic activity has been detected, however, in (i) the undissociated molecules of a strong or weak acid, (ii) the anion of a weak acid, (iii) the cation of a weak nitrogenous base.

Studies of Dynamic Isomerism. Part XXV. The Mechanism of Catalysis by Acids and Bases. By T. M. Lowry.

The catalysis by acids and bases of prototropic change and of hydrolysis is interpreted in terms of an electrolytic theory, according to which a flow of valency-electrons through the molecule is produced by bringing a proton-donator and a proton-acceptor, or a proton-donator and a hydroxyl-donator, into contact with the two terminals of the labile complex.

An explanation is given of the parts played, in the catalysis of isomeric change, by (i) neutral water, (ii) the molecules of a strong acid, and (iii) the anions of a weak acid, (iv) the cations of a weak base. The ineffectiveness of metallic cations in isomeric change, and of the anions of an acid in hydrolysis are also accounted for.

10-*Chloro-5 : 10-dihydrophenarsazine and its Derivatives. The General Method of Synthesis and Determination of Constitution.* By C. S. Gibson and J. D. A. Johnson.

The synthesis of 10-chloro-5 : 10-dihydrophenarsazine by preparation of *diphenylamine-o-arsinic acid* and subsequent ring closure was described. This method has been successfully applied to the synthesis and determination of the constitution of 10-chloro-4-methly - 5 : 10 - dihydrophenarsazine, 12 - chloro - 7 : 12-dihydrophenarsazin zine, 7-chloro - 7 : 12-dihydro*iso*benzophenarsazine, 12-chloro-7 : 12-dihydrobenzophenarsazine, 10-chloro-4-nitro-5 : 10-dihydrophenarsazine, 10-chloro-3 (or 1)-nitro-5 : 10-dihydrophenarsazine and 10-chloro-2-nitro-5 : 10-dihydrophenarsazine. The intermediate compounds and the corresponding phenarsazinic acids have been isolated in each case. Through the synthesis of the above nitro-compounds additional light has been thrown on the nitration of phenarsazinic acid.

Whilst N-*methyldiphenlyamine-o-arsinic acid* has been prepared, attempts to convert it into 10-chloro-5-methyl-5 :10-dihydrophenarsazine have been unsuccessful.

Active Nitrogen. The Independence of the Glow and Chemical Properties of Active Nitrogen. By E. J. B. WILLEY.

Spectroscopic and critical potential measurements suggest that active nitrogen is atomic in nature, and possesses a heat of formation of about 2—2.5 $\times 10^5$ g.-cal. per g.-mol., whereas the author's experiments have indicated that metastable molecules with an energy of only about 45,000 g.cal. per g.-mol. are involved.

The luminosity of " active " nitrogen can be destroyed by passage through a second weak discharge in a hot tube, without affecting the quantity of chemically-active nitrogen present; moreover, considerable chemical activity can be conferred on nitrogen by the action of an uncondensed alternating current discharge which does not, however, give rise to any luminosity in the gas thus treated.

It is concluded that " active " nitrogen consists of a mixture of a very small quantity of atoms, which on recombination give rise to the luminous phenomena, together with a much larger proportion of metastable diatomic molecules which are responsible for the chemical activity, but are not luminous. This hypothesis is in agreement with all the observed phenomena connected with active nitrogen, and is paralleled by the behaviour of other elements under the influence of the electric discharge.

THE OPTICAL SOCIETY.

Abstracts of papers read and discussed at the meeting of the Society on October 13 :—

Experiments in Ultra-Violet Refractometry. By L. C. MARTIN, D.I.C., A.R.C.S., D.Sc.

The experiments described have for their object the application of critical angle methods for the refractometry of liquids in the ultra-violet. A thin film of liquid can be held between two quartz hemispheres which are traversed centrally by an approximately parallel beam; the film receives the radiation at the varying angles of incidence resulting on rotation of the system. In this way, analysing the transmitted radiation with the aid of a quartz spectrograph, the critical angles for definite wave-lengths are measured, from which refractive indices can be calculated. The procedure necessary in seeeking precise results is discussed, and a series of measurements on glycerine-water mixtures likely to be useful for immersion fluids in ultra-violet microscopy is given. A set of interesting phenomena of the extinction bands is described and explained.

The Construction of Wave-Length Scales for Spectrograms. By GUY BARR, B.A., D.Sc. (Communicated by Dr. John S. Anderson.)

A method is described by which an approximate scale of wave-lengths may be projected geometrically from a uniformly divided scade on to a spectrogram whereon a sufficient number of lines have been identified to enable constants of a Hartmann interpolation formula to be derived. Such a scale is of value in assisting the recognition of other lines between which accurate interpolation may be required.

CHEMICAL, METALLURGICAL AND MINING SOCIETY OF SOUTH AFRICA.

The Ordinary Meeting was held at 100, Fox Street, Johannesburg, on August 20, 1927.

South African Legislation in Regard to Safety and Health in Mining. Presidential Address by SIR ROBERT N. KOTZE.

The assumption of office by a new President has to be signalised by the production of what is practically a paper written to order. It is true the selection of the subject of such a paper is left to the victim, but one result of such compulsory tribute is unavoidable. A paper written from external pressure is bound to lack the inspiration which may be expected when an author

writes because the inner spirit compels him to do so. If, however, you will bear with me while I discourse on my theme in the absence of such inner stimulus, I will try not to test your patience too severely.

I take for the subject of my address the history in South Africa of legislation intended to secure safety and health in mining operations, and will add some general remarks on the principles of the subject. As late Government Mining Engineer of the Union, I occupied a position which gives the occupant of that post a wide outlook on these questions and it may therefore be as well if I record some of my conclusions and reflections before my memory is dimmed by the passage of years. For assistance received in hunting up the historical references, I have to express my indebtedness to the Government Mining Engineer and his staff, and especially to Mr. F. C. Vaughan.

The earliest law relating to safety in mines in South Africa appears to have been Ordinance No. 3. of 1871, passed by the Republican Government of the Orange Free State in that year, and applicable to the diamond diggings of Griqualand West, which at that time formed part of the Orange Free State territory. The diggings, which later on proved to be on what is known as the Kimberley and De Beers diamond pipes, had been discovered in 1870. Griqualand West was annexed to the British Government in 1871 and it was administered from that year until 1880 by the Government of the Province of Griqualand West.

The Orange Free State Law of 1871 does not appear to have contained any specific provisions relating to safety, but it defined the duties of the Government Inspectors and empowered a body called the Diggers' Committee to make regulations to be approved by the Government. The Crown Colony Government of Griqualand West amended the law by Ordinance No. 10 of 1874 which vested in the Executive the power to frame rules and regulations for the control and management of diggings and mines. These powers, and the regulations that were issued in 1874 and 1880, of which I have been unable to secure a copy, remained in force till the Cape Colony Act No. 19 of 1883 was promulgated. In the meantime Griqualand West had been annexed to the Cape Colony in 1880.

The annual report for 1883 of the Inspector of Mines of the Cape makes no mention of any regulations, but it appears that the practice was for the Inspector to issue specific "Notices for Safety" to rectify defects. There were served upon the owner or accredited agent of the owner or owners, who was held responsible and occasionally prosecuted and fined up to £3 for non-compliance. In the 1883 report the Inspector comments on the unsatisfactory procedure of holding a man responsible who hardly ever saw the mine, instead of the manager or person actually in charge.

Act No. 19 of 1883 of the Cape empowered the Government to proclaim, from time to time, regulations for the safety of life and limb, for the proper management of mines and for determining the duties and powers of inspectors of mines. In 1884 a comprehensive set of regulations was proclaimed, dealing with mines, boilers, machinery and explosives. Originally these regulations applied only to mines on public diggings, but later legislation extended their application to private mines also. These laws and regulations remained in force until they were repealed and superseded by the Union Act No. 12 of 1911.

The Transvaal followed the example of the Orange Free State and the Cape at a later date. The first Act which has any reference to the safety and health in mines was No. 9 of 1888. It deals almost entirely with mining titles, but under Article 86, the President of the Republic was empowered to make regulations for safety in mines and for the rendering of returns of output.

A similar section appeared in the mining laws of the succeeding years but no regulations were ever promulgated, and in fact none were ever issued directly by the President under the powers thus conferred upon him. Act No. 9 of 1888 was also the first that empowered the President to appoint a State Mining Engineer, but this official post was only filled several years later.

The first mining regulations in the Transvaal were issued in 1893, and were comprised in Law No. 3 of 1893, which consisted of 141 Articles and covered pretty much the same field as the present regulations with the exception that there were no regulations dealing with boilers and certificates.

This law was passed by both the first and second Volksraads, and thus these regulations stood legally in the position of statute law, in contradistinction to our present regulations, which are issued by the Governor-General under the authority of a statute. In the same year Law No. 7 was passed consisting of a similar set of regulations relating to boilers. They were in the

me legal position as the mining regulations for that year.

These Transvaal laws were amended from ne to time until 1898, when two laws, s. 11 and 12 of 1898, finally superseded e previous mining and boiler regulations. ese remained in force until, under Crown lony Government, they were replaced by rdinances published in 1905.

It should also be mentioned that in 1893 rtain instructions to mine inspectors were ublished in Government Notice No. 226 of at year, under the authority of an Execuve Council resolution.

After the termination of the Anglo-Boer ar Ordinances Nos. 50 and 54 were promulgated in 1903. They comprised regulaions dealing with mines, works and achinery and with certificates. They were ubsequently amended by further Ordinnces, and by Acts passed by the Transvaal Parliament, but all these laws and amended aws were ultimately repealed and superseded by the Union Act No. 12 of 1911.

The principle of these later Transvaal Ordinances and Acts was different from that adopted under the Republican regime, in hat the Statute contained only a few provisions and empowered the Governor to issue regulations, which were then promulgated and amended from time to time without further reference to the supreme legislative authority.

In Natal the earliest law relating to safety and health was Act No. 43 of 1899. While it dealt mainly with the title, it also empowered the Governor, in Sections 140 to 143, to make regulations relating to the hours of labour, the limitations of the age of miners, ventilation and sanitation, workmen's quarters, and the support of mine workings and generally to the safe and proper workings of mines. In 1900 comprehensive regulations were issued under these powers. The age limit for underground workers was put at twelve years—as compared to the present limit of sixteen years.

A curiosity is that one regulation, No. 85, empowers an official, the Controller of Arms, to issue regulations for the storage of explosives on the surface of mines. We have here an instance of the Governor delegating his powers to an official, a proceeding which the Natal Parliament no doubt never intended. The legality of it appears however never to have been questioned, and regulations were duly issued by the Controller of Arms.

An examination of the Statutes at present in force, namely, Acts No. 12 of 1911 and No. 25 of 1926 and of the regulations issued under them will show that the statute law is brief, while the regulations are numerous and embrace provisions ranging in importance from the relatively insignificant to such as embody matters of first-class principle. The main Statute, Law No. 12 of 1911, contains only a few sections, dealing with the sex and minimum age of workers, the permissible extent of Sunday labour, the maximum hours per day of labour underground, certain powers of inspectors of mines, penalty clauses, and definitions of important terms. It confers extensive powers to make regulations on the Governor-General. Act No. 25 of 1926 gives power to confer different duties and privileges upon Europeans and upon natives, and is the so-called Colour Bar Act.

To supplement these brief statutory provisions, some of which need amending to bring them up to date and to make them more workable, there are several regulations which are of such fundamental importance that they should have the imprimatur of Parliament and not be relegated to the discretion of the Government. A comparison of the British law and our own in these respects is instructive. The main British Statute, the Coal Mines Act of 1911 contains 127 Sections as against 19 in our law of 1911. In my opinion the British statute errs at least as much in embracing too many details as our statute does in leaving too many important matters of principle to the regulations. The dividing line is perhaps not too easy to define, but broadly speaking, the statute should deal with principles and not with details, and especially not with technical details, the effect and justice of which cannot be adequatey grasped or debated in a deliberative body constituted as Parliament is. Moreover, the Statute Law cannot be altered except by Parliament. When improved technique or wider scientific knowledge calls for an amendment of a technical provision it is preferable to have the law in the form of a regulation rather than in that of a statute. Regulations can be readily altered by the Government after adequate discussions of the technicalities with competent interested parties, and the necessary elacticity is therefore secured by putting the alterable details in the regulation and confining the statute to the rigid and unalterable principles.

As an allustrative example we may take the law governing the ventilation of mines.

The South African Statute contains absolutely no provision relating to this important matter, which is dealt with entirely by a considerable number of detailed regulations. The British Coal Mines Act of 1911 contains three lengthy sections on the subject. Many of the detailed provisions of these three sections are so technical that not one tenth of the members of the British Parliament could have understood them, much le ss have deliberated intelligently upon them. One would suggest that a short section stipulating that adequate ventilation shall be provided in all places where persons have to work or travel, should suffice for the statute, leaving the technical details to be covered by regulations. An even more striking example of the detailed nature of the British Statute law is to be found in the sections dealing with shafts and travelling ways. These cover thirteen sections occupying fifteen pages of the 1919 edition. The provisions are highly technical and hardly any of them could have been understood by any members of Parliament outside the small number of mining representatives. The other members could only have voted on them as they were directed. Nearly all of these provisions could have been left to be dealt with under regulations. One could take chapter after chapter of the British law in the same way. The South African Act on the other hand leaves too much to the regulations. It would be difficult to suggest ,within the limits of a short Presidential Address, what a model Act should comprise, and it is not my intention to inflict a Draft Bill on you, but generally I think I may say that the Act should approximate more nearly to the South African Statute than to the British. It should, in addition to the present provisions of the South African Act, include a section defining the duties and responsibilities of managers and of the chief officials, and have other sections prescribing the hours of labour and providing for sanitation, ventilation and health, for the rendering of returns, the support of underground workings, keeping of plans, examinations for safety, and sundry other matters which are too important to leave to control by regulation and which can be deliberated understandingly by any Member of Parliament. Technical intricacies may well be left to be thrashed out between the technical Government officials, the mine owners and the mine employees and incorporated in regulations when finally decided upon.

FORTHCOMING EVENTS.

Tuesday, November 1.

THE INSTITUTION OF CIVIL ENGINEERS.

Great George Street, Westminster, S.W.

At 6 p.m.—Mr. Ernest Frederick Crosl Trench, C.B.E., M.A., B.A.I., will deliv his inaugural address at the opening mee ing of the 109th Session of the Institutic

THE ROYAL INSTITUTION OF GREAT BRITAIN.

Albemarle Street, London, W.1.

At 5.15 p.m.—" Light and Sight." I Sir John Herbert Parsons, C.B.E., Ll.D F.R.S., F.R.C.S.

THE INSTITUTION OF ELECTRICAI ENGINEERS.

North-Midland Centre. At the Hot Metropole, Leeds, at 7.15 p.m.—Inaugur address by J. E. Storr, chairman.

North-Western Centre, at the Midlai Hotel, Manchester.—Inaugural address l A. B. Mallinson, the chairman.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

At 5.30 p.m.

INSTITUTE OF METALS.

N.E. Coast Local Section, at Armstroi College, Newcastle, at 7.30 p.m.—" Mec anical Properties of Metals at High Pr sures." By Geo. Burns, B.Met.

MINERALOGICAL SOCIETY.

At 5.30.—Anniversary Meeting. Dr. J. Spencer : "Specific Gravities of Mineral An Index of Some Recent Determinations Dr. L. J. Spencer : " South African Occu rences of Willemite." " Fluorescence Willemite and Some Other Zinc Minerals Ultra-Violet Rays." Dr. T. V. M. Rac " A Study of Bauxite." Dr. P. K. Ghosh " On the Biotite-bearing Greenstones ar on a Rhyolitic Pumice in the Metamorph Aureole of the Falmouth Granite."

Wednesday, November 2.

SOCIETY OF PUBLIC ANALYSTS.

In the Theatre of St. Mary's Hospital (the invitation of the Pathological Instit tion of that Hospital).

UNIVERSITY COLLEGE.

Gower Street, London, W.1.

At 8 p.m.—Barlow Lectures on Dant " Dante in alcuni giudizi contemporanei First of a Course of four public lectures Italian, by Dr. C. Pellizzi. November 2, 16, and 23.

At 5 p.m.—"The Roots of Character." . public introductory lecture by Dr. rynce Hopkins.

At 5.30 p.m.—"Nineteenth Century [ethods of Book Illustration." A public ecture by Major Cyril Davenport, V.D., '.S.A. (Lantern Illustrations.)

GEOLOGICAL SOCIETY.

Burlington House, London, W.1.

At 5.30 p.m.—"*The Stratigraphical Disribution* of the Cornbrash : I—The South-Vestern Area." By James Archibald)ouglas, M.A., D.Sc., Sec. G.S., and Villiam Joscelyn Arkell, B.A., B.Sc., '.G.S.

SOCIETY OF PUBLIC ANALYSTS.

At 8.15 p.m.—*In the Theatre of the* Institute of Pathology and Research, St. Mary's Hospital ,Paddington (entrance at he corner of Praed Street and Cambridge Place), by invitation of Sir Almroth Wright, F.R.S., *and the Members of that Institute.* The following papers will be read :—"The Biological Tests for Blood." By Sir William Willcox, .C.I.E., M.D., F.I.C. "The Technique of the Precipitin Test and its Forensic Value." By G. Roche Lynch, O.B.E., M.B., B.S., D.P.H. "The Use of the Blood Grouping Reactions in Forensic Investigation." By F. C. Martley, M.A., M.D., F.R.C.P.I.

ROYAL SOCIETY OF ARTS.

John Street, Adelphi, London.

At 8 p.m.—*(Inaugural Meeting.)* Sir Philip Magnus, Bt., Chairman of the Council of the Society : "The Royal Society of Arts : Its Services to Trade and Training."

INSTITUTION OF PUBLIC HEALTH.

37, Russell Square, London, W.C.1.

At 2 p.m.—"Tuberculosis as a Problem of Childhood." By Sir Henry Gauvain, M.A., M.D., M.C. ; and at 4 p.m., with lantern slides.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Wireless Section.—At 6 p.m.—Inaugural Address by Lt.-Col. A. G. Lee, O.B.E., M.C.

Thursday, November 3.

UNIVERSITY COLLEGE.

Gower Street, London, W.C.1.

At 5.15 p.m.—"Customary Law in the British Empire." First of a Course of seven public lectures by Prof. J. E. G. de Montmorency. November 3, 10, 17, 24, December 1, 8 and 15.

At 5.30 p.m.—"The Neapolitan Revolution of 1799." A public lecture by Prof. Edmund G. Gardner.

At 5.30 p.m.—"The Use of Literature to Influence Conduct : Some Effects of Reading Poetry." A public introductory lecture by Dr. Prynce Hopkins.

INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, London, W.C.2.

At 6 p.m.—"Higher Steam Pressures and their Application to the Steam Turbine." By *A. H. Law and J. P. Chittenden.*

ROYAL INSTITUTION.

Albemarle Street, London, W.1.

At 5.15 p.m.—"The Furniture and Equipment of the Mediæval House." By H. Clifford Smith ,M.A., F.S.A. (Assistant *Keeeper, Victoria and Albert Museum).*

Saturday, November 5.

ROYAL INSTITUTION.

Albemarle Street, London, W.1.

At 3 p.m.—"The Main Features of Modern English Literature." By Emile Cammaerts, C.B.E., F.R.Hist.S., Chevalier de l'Order de Leopold.

NOTICES OF BOOKS.

NEW GERMAN BOOKS.

(1) *Organische Molekulverbindungen.* By Prof. Paul Pfeiffer. Second, enlarged edition. Pp. xvi + 470. Stuttgart : Verlag von Ferdinand Enke. 1927. Price 40 marks.

It is gratifying to notice that Prof. Pfeiffer's important work on molecular compounds, a treatise of purely theoretical interest and of comparatively limited appeal, has reached a second edition.

The subject is one upon which the author has made so many lengthy contributions in the German scientific literature. He has collected together his own publications in this field and pieced them together with those of other investigators. After a general account of the nature of molecular combinations a systematic study is made of organic-inorganic double compounds and purely organic molecular compounds. The number of such substances in both sections is surprisingly large. Prof. Pfeiffer himself has prepared many hundreds of them in the course of his researches. But in his compilation he does not seem to have made full use of the English contributions to his subject. He seems to have relied very largely upon the *Chemisches Zentrallblatt*

for his information on work published outside Germany.

He endeavours to explain the structure of the compounds formed by apparently saturated molecules with one another. In these complexes a univalent atom or group is often replaced by H_2O or NH_3, without diminishing the stability of the complex. Prof. Pfeiffer inclines to Werner's Co-ordination Theory to account for their existence.

(2) *Lehrbuch der Thermostatik* nach der Vorlesungen von PROF. J. D. v. D. WAALS bearbeitet von PROF. P. KOHNSTAMM. Pp. xvi + 390. Leipzig: Johann Ambrosius Barth. 1927. Price, 22 marks.

Prof. Kohnstamm describes this work as the third edition of van der Waals' *Thermodyanmik*. Twenty years' use of the text-book has led him to prepare a third edition under a slightly different title, retaining the ground plan of the original, but expanding and amplifying it where necessary. Only the section on the theory of Capillarity, which occupies a quarter of the volume, remains unchanged.

(3) *Die Welt der vernachlassigten Dimensionen*. By WOLFGANG OSTWALD. Ninth and tenth editions. Pp. xvi + 325. Dresden and Leipzig: T. Steinkopff. 1927. Price, 12 marks.

This propaganda volume on colloid chemistry is probably one of the most widely read works on the subject. It arose from the lectures Prof. Ostwald gave in 1914 in America and has been continually revised in succeeding editions. This one is nearly half as large again as the previous one.

The author, who has done so much to elucidate the nature of disperse systems, endeavours to make clear to the widest possible number of readers exactly what the colloidal state is and in what ways substances are made to assume this state. He goes on to emphasise the importance of as complete a knowledge as possible in order to understand the modes of applying them to industrial processes.

(4) *Die Valenzzahl*. By H. LESSHEIM AND R. SAMUEL. Pp. 98. Berlin: Gebr. Borntraeger. 1927. Price 6 marks 50 pf.

Ever since the general acceptance of Mendelejev's Periodic classification of the elements, valency has been the object of much enquiry and speculation. Recent progress in atomic physics has served to attract more attention to the problems and anomalies associated with valency. The German authors of this volume are concerned with the connection between valency and atomic structure and show how th chemical nature of the elements follows fro their atomic constitution.

An account appeared in *The Chemic News*, 1925, cxxxi, 87, of some schemes t which (and the references there given) tl present authors' attention is directed.

(5) *Lassar Cohn's Praxis der Harnanaly* Seventh edition by DR. R. RAPP. Pp. 6 Leipzig: Leopold Voss. 1927. Price marks 20 pf.

Prof. Lassar-Cohn's volume on uri analysis first appeared in 1897 and has no reached the seventh edition which has bee revised by Dr. Rapp. The new matter i cludes the chapter on normal urine, whil those on phosphates and various estim tions have been brought up to date. Rece practice in the examination of stoma contents has also found a place and mo importance is now given to micro-chemic tests.

(6) *Abderhalden' Handbuch der bi logischen Arbeitsmethoden*. Abt. I., Teil erste Halfte, Heft 2. Lieferung 234. P 457-642. Berlin and Vienna: Urban a Schwarzenberg. 1927. Price 10 marks.

The latest section of Prof. Abderhalden *Handbuch* is noteworthy in being eminent practical. Dr. Edlbacher's section Diazotisation only occupies 6 pages b gives all that is needed and with a suf ciency of references and details adequa enough for a biologist or chemist to condu a diazotisation progess. The author pro ably does not know that in 1914 a good w of making an ethereal solution of diazo ethane was described in the *Chemical New*

Both the other two contributio (Alkali Fusion Methods; Nitration) a from Dr. E. Maschmann, who points o that alkali fusion methods are the m drastic processes in organic chemistry. I enumerates a number of syntheses depen ent upon this type of reaction, and descri its application in biochemcal work. T article on nitration is very informative a lengthy and describes a large number preparations and syntheses indicating exhaustive search of the literature.

(7) *Leim und Gelatin*, By DR. E. SAU Pp. 57. Dresden and Leipzig: Theod Steinkopff. 1927. Price 3 marks.

The scientific basis for the extraction glue and gelatine is not so much dependa on their chemical properties as upon th physical and colloid properties. Research on their nature and properties have been the greatest value in elucidating the natu

of the colloidal state. Dr. Sauer's volume (which is taken from a part of Prof. Liesegang's *Kolloidchemischen Technologie*) is chiefly devoted to an account of their industrial extraction, evaluation and uses.

Its title recalls to the reviewer that three years ago a London chemical contemporary reported that a German chemist had converted " lime and gelatine " into pearls. Consultation of the original showed that the word "*Leim*," had been translated "*lime*."

J. G. F. D.

General Chemistry, Theoretical and Descriptive. By THOMAS P. MCCUTCHEON, Ph.D. (Professor of Inorganic Chemistry, University of Pennsylvania), AND HARRY SELZ, Ph.D. (Assistant Prof. of Physical Chemistry, Carnegie Institute of Technology). Pp. x + 416. Price 16s. London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2.

Based on a series of illustrated lectures, this book has been designed as for use in a course of General Chemistry, and both in its contents and arrangement it will answer the purpose of the authors.

The work is divided into two parts, theoretical and descriptive, an arrangement which will meet the requirements of pupils and command the approval of the instructor. The syllabus of the lectures on which the work is based comprises 31 items. Facing the title page (for easy reference) is a Table of the Elements—symbols, numbers, and atomic weights. There is a detailed alphabetical index, extending to 27 pages, besides a summary of contents. It is a well-written, carefully arranged, and useful work.

Hydrochloric Acid and Sodium Sulphate. By N. A. LAURY, Consulting Chemical Engineer (American Chemical Society Monograph Series). Pp. 128. Price 4 dollars. The American Chemical Catalog Company, Inc., 419, Fourth Avenue, at 29th Street, New York.

This is one of the technical monograph books, the production of which was undertaken by the Americal Chemical Society at the Inter-Allied Conference which was held at Brussels in 1919. Issued under such auspices, the work needs very little in the way of review or commendation. The present monograph is compact, and gives the desirable information as regards properties, compounds, equipment, in such form as to keep the size of the work to convenient proportions. There is no space wasted on unnecessary information. Essential formulæ and tables are given and so are illustrations of the necessary furnaces and other apparati which will prove of special interest to chemical manufacturers.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

26,056.—Lambert, B. — Manufacture of sulphuric acid. October 3rd.

26,224.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of white titanic acid. October 4th.

26,225.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of cyanogen chloride. October 4th.

Specifications Published.

278,086.—Ludecke, K., and Ludecke, N.—Process for the production of glycerine from sugar by fermentation in an alkaline medium.

278,211.—U.S. Industrial Alcohol Co.—Process for the distillation of alcohol.

265,624.—I. G. Farbenindustrie Akt.-Ges. —Catalytic oxidation of carbon monoxide.

266,735.—I. G. Farbenindustrie Akt.-Ges. —Treatment of crude nitrate of soda (caliche).

Abstract Published.

276,146.—Carbon dioxide.—Geere, E. W., 172, Kingshall Road, Beckenham, Kent.

In the controlled production of carbon dioxide by the action of carbonates or bicarbonates of solid acids or their acid salts coated with wax, hydrogenated oil or fat, or other medium of any desired melting point, the acid substance is first made into a homogeneous mixture with the wax or like, and then further quantities of the acid substance, varied according to the strength desired ,are completely combined with the mixture, *e.g.*, by edge-runner, roller, disintegrator, or other mills. Acids substances specified are citric and tartaric acids, their acid salts, and acid phosphates and sulphates, or any mixture thereof.

275,284.—Alcohols, etc.—I. G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany.

In the manufacture of oxygenated organic compounds such as higher alcohols by the catalytic hydrogenation of carbon monoxide at elevated temperature and pressure, the carbon dioxide formed is removed continuously or periodically by absorption in solvents such as water or by binding it chemically under high pressure. The amount of carbon dioxide in the gases is not allowed to exceed 3 per cent. The reacting hydrogen may be replaced by alcohols or hydrocarbons. According to the examples (1) water gas is circulated at 200 atmospheres pressure over a mixture of equimolecular proportions of zinc oxide, chromium oxide and manganese oxide heated to a temperature of 475-500° C.; the issuing gases are cooled to remove methanol, isobutyl alcohol, etc., and the carbon dioxide formed is eliminated by absorption in water without releasing the reaction pressure; () a mixture of carbon monoxide, hydrogen and nitrogen is charged with ethyl alcohol vapour and passed over the same catalyst as before and under the same pressure and temperature conditions; the same products are condensed and the gases are freed from carbon dioxide by treatment with water, to which a little ammonia may be added, while still under pressure. Specifications 20488/13 and 229,714 are referred to.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

MONDOL.

483,740.—All goods in glass 2 hich includes chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—The Mond Staffordshire Refining Co., Ltd., 47, Victoria Street, London, S.W.1. October 12th.

GENERAL INDEX TO THE "CHEMICAL NEWS"—VOLS. 1 TO 100.

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THE CHEMICAL NEWS

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AGRICULTURE AND NATIONAL EDUCATION.

By C. G. T. MORISON, M.A., President of the Agriculture Section.

(*Before the British Association for the Advancement of Science.*)

(*Continued from Last Week.*)

The landlord may, or may not, remain as a permanent partner in the agricultural industry; but while he does remain the power that he possesses of influencing the whole industry is enormous. Those of us who were privileged to hear Lord Bledisloe's address when he was President of this section will well remember his almost passionate appeal to the landowners of to-day to follow the example set them by their illustrious predecessors, and take upon themselves the position of leaders and organisers of the agricultural industry. Some there are of course who, like Lord Bledisloe himself, have taken up this burden, and whose names will be remembered as we remember those of the great leaders of the eighteenth century. 'The agricultural community in Britain to-day,' said Lord Bledisloe at Hull in 1922, 'above all else needs enlightened leadership, just as agriculture needs efficient organisation; and the landowner, if after due training, he would but take his proper position, should be both leader and chief organiser.' This need for leadership all over the world is as great to-day as it was then, and, while the owners of the soil supply leaders in almost every branch of this country's activities, they undoubtedly do so in smaller numbers in the very industry from which they have derived their position. This leadership is only possible to-day through suitable education, and if it is possible to provide suitable education for any class in the community, it should be possible in this case. The preparatory and public schools of this country, great as their faults, may be, do undoubtedly at their best, furnish an education which in certain aspects is surpassed by none, and provide a training in citizenship and leadership which it is difficult to equad. Specialisation and vocational training are, however, relegated to the last years of a public-school career, and so far in this country agriculture has been treated as a purely vocational subject, to be dealt with shortly in the secondary school as a preliminary to a fuller course in the subject at a subsequent stage. So the prospective landlord passes from the school stage to the university, where now he may, if he be so minded, spend the whole of his time completing his cultural and technical education and training himself for this occupation of leadership. And if the schools and universities of this country live up to their reputation, and if the latter seriously attend to the provision of the most suitable curricula, the education and training will be sufficient. In Lord Bledisloe's words, 'their traditions are great, but their future destiny is greater if they have but the vision, the courage, and, above all, the will to press resolutely forward towards the goal to which public duty and material advantage alike point the way.'

What, then, is the actual farmer's position? On him the greater part of the burden falls; how does the education provided help him to support it?

In the case of the larger farmers general education and technical training will be provided by means identical, or nearly so, to those I have already discussed, and they with the landowner must share the burden of leadership, leadership not only in technical skill and administrative ability, but also in the more difficult task of building up a new rural life. In the case of the smaller farmers, the facilities are not so somplete; the majority of these get their education at the local grammar schools, which usually require that a boy shall enter before the age of twelve and shal lstay until the age of sixteen. In this way it should be possible to secure that the general education is satisfactory, and that it should have what is called a rural bias, or at any rate be closely related to environment in country districts. It has been shown by a committee of this Association on Training for Overseas Life that quite a number of grammar and secondary schools have introdnced some agricultural work of a kind which may be regarded as semi-vocational, as something which would definitely be of service when the boy leaves school, as he usually does, between the ages of sixteen and seventeen. Definite technical education is subsequently provided by the Agricultural olleges, by the Farm Institutes, and the activities of the County Council officer in the way of lectures, demonstrations, visits to institutions, discussion groups, and young farmers' clubs. I feel, however, that this is not enough, good though it frequently is and excellent as it may become. Something further is required, some scheme whereby education may be continued in later years and not cut o short at the time when it is perhaps most worth continuing. Is it too much to hope that there may develop in this country something in the nature of a rural university which shall continue education, and shall continue it on university lines? If I am correct, what is needed is not a greater volume of technical instruction bnt a greater desire for technical instruction and a more educated habit of mind, which I believe can only be obtained in these cases by an improvement in, and a continuation of, general education to a later stage.

It is frequently, though not universally, held that much of the success of modern Danish agricultural organisation is due to the existence of the famous Folk High Schools, virtually rural universities, providing as they do in a manner which is unique the advantages of a residential university. It would take too long to examine the claim that has been made that without these schools Danish agricultural co-operation and Danish agricultural progress would have been impossible, but even if we make allowance for the enthusiasm of the believers, it is certain that much of the mental alertness and spirit of mutual help so essential to success has been acquired in the High School. In Denmark even up to the present day these have been almost entirely a rural development; the towns have been unwilling and slow to support the movement. It must be frankly admitted that it does not appear possible, with the English outlook on education, to transplant the High-school system into this country, but I do believe that in the development of the spirit which led to their foundation lies the greatest hope for the future of rural England. How far is it possible that this work can be carried out through the instrumentality of such organisations as the Extra-mural Delegacies of the Universities, Rural Community Councils, Women's Institutes and other bodies which are interested in the regeneration of the countryside? The success of the Women's Institutes has been very remarkable, and the potentialities of the Extramural work of the Universities are as yet hardly explored. If we look at the report of the Extra-mural Delegacy of my own University, we shall see that courses, which have been more or less well attended, have been given in purely rural areas on such subjects as "Citizenship and How England is Governed," "Industrial History," "Current Economic Problems," all of which themes, to mention only a few, might be expected to interest a country audience. Some of the lectures deal specifically with rural affairs and their development, and it is interesting to learn that in the smaller centres, in the more purely agricultural districts, the audience generally consists of the parson, the schoolmaster, village shopkeepers, sometimes farm labourers and their wives, frequently farmers' wives, but practically never the farmers themselves. I do not pretend to know what is the reason for this abstention on the part of the farmers, but it does indicate an attitude of mind that is to be deplored, and which must hinder any attempt to improve rural conditions.

Turning next to the case of the wage-earner in the industry, as has been pointed out by Mr. Duncan, nothing has been attempted so far which will either improve his

technical training or prolong his education; the improvement, such as it is, that has been effected in the skill and knowledge of the farmer has only intensified the difference between master and man. One of the real needs of the industry is to keep the best men on the land, not those who for one reason or another get left behind in the race to the towns, and this will only be possible when the employer can pay wages comparable with those which can be obtained in other industries. This he is unable to do, and will continue to be unable to do, until it is possible to increase the value of the worker's output. I would here remark that in other industries employers have found out the value of prolonged education, as well as of vocational training, and the real worth of continuation classes has been clearly demonstrated. Is it too much to hope that something of the same kind may happen in the industry in which we are all interested? Much is being done towards the improvement of elementary education, and many persons are interested in this side of the problem. The development of Senior Country Schools and the possibilities that are to be found in such a scheme of fostering a liking for, and an understanding of, rural affairs are all happy auguries for a brighter future. Any improvement that can be effected, however, in the ordinary schools is likely to be very largely sterile, unless it is possible to continue this education over the critical years that follow the school-leaving age. Is is too much of a dream to look forward to an improvement in the general education and training of those who are engaged in agricultural pursuits, to a time when farmers up and down the country will feel that there is something worth while in an education and a standard of culture and technical knowledge beyond that to which they have been accustomed, and when they will be prepared adequately to remunerate good men whose output is high, and when the men themselves will realise that only if they have adequate education and traning can they expect to earn wages comparable to those paid in urban industries?

I desire to turn now to two other aspects of agriculture in relation to national education, one of which I regard as having very great significance from the point of view of the industry itself, and the other as being at this stage in the development of the world of paramount importance to every civilised community. It has long been the complaint of persons interested in agriculture that it is very difficult to arouse intelligent interest in the minds of those persons in the country who are not either directly or indirectly concerned with the industry. There have, of course, been times in the history of every country when circumpossibility of actual starvation, have drawn the attention of the whole population to this question. Under such circumstances governments may have to act precipitately and commit the country to this or that policy without sufficient consideration. Such a course is fraught with much danger, especially when dealing with an industry like agriculture in which changes can only come slowly and gradually. In the present day, when our needs are satisfied by produce from all parts of the world, and when only a small portion of the food consumed both in the towns and in the country is provided by our own soil, is it not time that some effort was made to inform the whole body of consumers, not only of the way in which the food is produced, but of the manner of life of those who produce it, and of the mode of its arrival in their midst? So smoothly does the machinery of production and distribution appear to work that the consumer is apt to think it automatic, and to take the arrival of these necessaries and luxuries almost as the falling of manna from heaven. Only by education, only by creating an informed opinion about agriculture among both the urban and rural populations in this country, can the mass of the people come to realise the peculiar circumstances of the farming community, and the difficulties with which their business is faced, and the particular problems that affect the countryside as distinct from the towns.

To proceed still further, Sir Daniel Hall, in his Presidential Address last year, emphasised the fact that the continued expansion of the earth's population and of the white races in particular, as representing the highest material standard of living, will demand either a great expansion in the area of land under cultivation, or an intensification of production in the area at present utilised. It is apparent from the papers that have been written in America by Dr. E. D. Ball, that, even in the United States which has up till recently been a large exporter of food, the question of a national agricultural policy is regarded as most urgent. He asserts that the United States will only maintain her world position and her extraordinary development just as long as she can remain a food exporting nation,

and this can only be achieved if the whole energies of her scientific men are devoted to the intensification of production upon land already farmed. The need for this intensification appears then to be as great in America as here, and this calls for continued scientific research, not so much to ensure the benefit of any particular class of the community, however deserving, but because the nation needs it, because it is vital to the life of each and every individual. In Sir Daniel Hall's view the area of suitable undeveloped land available is insufficient to provide the increase of food required, and, in his own concluding words, "how close at hand the period of pressure may be it is unsafe to prophesy, but it may be agreed that pressure is sooner or later inevitable, and that one of the biggest problems before the world at present is to prevent the pressure developing suddenly and becoming unbearable. The intensification of production is the only remedy, and again the only means of rendering intensification practicable is the continued pursuit of scientific research."

This intensification of production must come sooner or later in an ever-growing population, and can only be brought about by increasing knowledge and improving technique. Before this intensification can occur, the nations must realise the need for further investigation and research, and this they will only do if and when there exists among the citizens of every civilised community a widespread knowledge of this the most basal of all human activities.

(To be continued.)

A NOTE ON RADIATION.

By F. H. Loring.

From the previous studies by the writer —see in particular *Chemical News*, July 29, 1927, p. 65, and same Journal, February 18, 1927, p. 97—c can be evaluated from Δ_a or Δ_H and R_{inf}, which seems to imply that the velocity of light has a *basis* in the atom.* The photo-electric effect (see latter reference above) involves greater energy than spread-out radiation allows, considering the small area of the atom, and this seems to imply that the atom when photo-electrically excited draws or makes up the quantum required ($h\nu_{spec}$) from a universal reservoir of latent energy.

The loss to space of enormous outpourings or radiant energy from billions of suns seems to imply that the end-product, whatever form of energy it may be, is contained in the vast seas of space, in interstellar space.

In seeking a parallel, which must be electric or electromagnetic as radiation is such, consider the case of a cable connecting, say, Liverpool with New York. When the circuit is completed through the ocean by dipping the Liverpool electrode into the Mersey, it is not possible to conceive electrons crossing from New York to Liverpool through the ocean and practically instantaneously meeting the electrode the moment it enters the Mersey. This would involve superhuman intelligence on the part of the electrons, and prodigious agility. It is easier to conceive the ocean as a reservoir, which if pumped into at one place may be pumped out of at another, only the water is not the flowing medium, but the electrons. The cable confines the electrons so that they pass on quickly it is true.

Again, electrons in motion, electric conduction in particular, set up magnetic fields round them; for, along and round the movement there is a field that is best represented by closed lines or circles round the conductor, but extending out indefinitely without any absolute limit when considered as a whole. In practice the limit is soon reached. On the other hand, where the electron-movement stops or wants to continue there is another field or strain set up, called the *electrostatic field*. Line elements of each field are at right angles to one another. The electrostatic field is extensive like the magnetic field. The electrons are confined to the conductor. This is all very elementary but worthy of mention.

Now there are dual phases in each phenomenon. Radiation which spreads and the photo-electric effect which is localised and atomic.

Electric conduction which is localised in the conductor is atomic, and the fields set up expand or spread. Consider the parallels.

Drawing from the universal reservoir in the case of the photo-electric effect.

Drawing from the ocean reservoir in the case of completing the circuit in the Mersey.

These effects have bases that are parallel. c has a basis in the atom, yet c is virtually the spreading constant. The field round a

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* Michelson in his "Studies in Optics," 1927, gives his precision value for c as (2.99796 *plus or minus* 0.00001, × 10_{10} cms/sec.

conductor has an atomic basis in the conductor, for the electrons are like atoms and move progressively through it. The closing of the circuit at Liverpool has a basis in the cable very much as the photo-electric effect has a basis in the ray extending from the source to the particular electron thrown out of the atom.

It is perhaps along lines somewhat as here suggested we may come by degrees to understand radiation and the difference between it and quanta, and that spreading radiation is not in conflict, but complementary as indicated above. That the problem is very far from complete solution is, however, evident.

COLD BLAST PIG IRON.

Some Unsolved Problems in the Science of Metallurgy.

By A Well-Known Engineer.

It is a remarkable fact not only that the chemical reactions of the blast furnace remain almost as mysterious as ever, but also that all the modern improvements in the way of throughput, control by chemical analysis, and reduction in the consumption of coke per ton of pig iron have done nothing to improve the quality of the pig iron. In this connection very interesting and important is genuine cold blast pig iron, that is made by operating the furnace with cold air instead of preheating by means of a "Cowper" stove or other contrivance. Admittedly such cold blast working is more costly, because of the reduced thermal efficiency, but it is a paying proposition to-day in many different operations to employ genuine cold blast iron, which is of a peculiarly dense and tough character, one of the best examples of its value being the internal combustion engine.

Iron of this character is a speciality of Messrs. Robert Heath and Low Moor Ltd., and has been made at their Low Moor Works ever since 1791, the blast furnace plant having no "Cowper" stove or similar arrangement for preheating the air, which is supplied cold at varying pressures up to 3½ lbs. per square inch, the average throughput being about 250 tons of iron a week.

There is still no scientific explanation for the valuable properties of cold blast iron in spite of all the theories that have been advanced. The chemical analysis for example of a grade such as used for chilled castings shows 0.70 to 1.50 per cent. silicon; 0.05 to 0.14 per cent. sulphur; 0.40 to 0.50 per cent. phosphorus; 0.60 to 1.25 per cent. manganese; 2.80 to 2.85 per cent. graphitic carbon; and 0.60 to 0.65 per cent. combined carbon. This, however, does not give much indication except in the way of being a high-grade iron very low in phosphorus. Certainly the coke used is also low in total sulphur, averaging 0.45 per cent., from the firm's own "Better Bed" coal, but as in the case of iron, steel, coal, and coke for example, chemical analysis is only a partial guide. Finally, it may be stated cold blast iron is particularly suitable for much chemical engineerin gplant, including autoclaves, evaporaters, pans, tanks, and pumps.

THE FERTILISER INDUSTRY.

Address Prepared by The Right Hon. Sir Alfred Mond, Bt., M.P. (Chairman, Imperial Chemical Industries, Ltd.), for The Imperial Agricultural Research Conference, Billingham, Tuesday 18 October, 1927.

"In offering a hearty welcome to you as members of the Imperial Agricultural Research Conference, I would like to say how very glad we all here are to see representatives from every corner of the far-flung British Empire gathered together to discuss the most important and most ancient of all industries and how it can be improved. The agricultural problems of the Empire are diverse in many ways, but they have at least this as a great common factor—their attitude towards the use of fertilisers. The programme of a conference which I have been very interested to read involves a whole month of meetings and visits. The problems to be dealt with include such administrative ones as recruitment, interchange of information and a chain of research stations and such vital technical problems as plant pathology, preservation, crops and plant breeding, animal nutrition, agricultural economics, and last but not least soils and fertilisers. The places to be visited range from Cambridge to Aberdeen and from Belfast to Billingham.

As you are better aware than I am, the population of this country has lived for several generations on the stored up reserves of fertility of the virgin plains of the world.

That these could not last for ever has been manifest to all thinking men for a long

time. My own father, who as you know, was one of the greatest chemical pioneers this country ever produced, in his presidential address to the Society of Chemical Industry, delivered nearly forty years ago, said : ' Science tells us how very far we are from attaining our industrial aims with anything approaching the theoretical expenditure of force. Science also tells us in what directions we may look forward to arriving at improvements. I might say that we are on the eve of creating a science of invention, that is, of developing scientific methods for solving industrial problems. As exemplifying to a certain extent the application of methodical research to an industrial problem, I propose to bring before you to-day an account of the work I have been engaged in for many years in relation to the procuring of new and abundant supplies of ammonia, and to investigations connected therewith.

Through the classical researches of Lawes and Gilbert, who proved, in opposition to no less an authority than Leibig, that ammonia is a most valuable manure, which enables us not only to maintain, but to multiply the yields of our fields, and thus to feed on the same area a much larger number of inhabitants, the immense importance of an abundant supply of ammonia, more particularly for the old world, with its teeming population and worn out soil, has been apparent to everyone.

For many years Europe has paid to South America millions upon millions of pounds for ammonia in the shape of guano, and more recently, since the supply of guano practically ceased, for nitrate of soda, which effectually serves the same purpose as ammonia. During the past year South America exported seven hundred aud fifty thousand tons of nitrate, of which six hundred and fifty thousand went to Europe, representing a value of not less than six and a half million pounds.

The problem of saving this immense expenditure to Europe, of making ourselves independent of a country so far away for the supply of the material upon which the prosperity of our agriculture—our most important industry—depends, by supplying this ammonia from sources at our own command, is certainly one of the most important which our science has to solve.'

I am sure you will agree with me that these words have a very modern ring about them. They were spoken nine years before the well-known address to the British Association of the late Sir William Crookes in 1898. References to his own investigations are of course to the by-product ammonia of the Mond Gas process, and standing here near our new great works I can say with some pride that we have solved the question he set with the spirit which animated him.

You have already in your hands a booklet dealing with the main features of this great factory. I therefore propose to tell you something of the way in which this organisation began, and of the difficulties the eventual solution of which constitutes one of the most brilliant triumphs of British engineering and chemistry.

At the outset our carefully chosen staff, picked men, who have so well justified their selection, were entirely without similar experience. As you know this process operates at very high pressures, running into thousands of pounds per square inch. The mastery of high pressure technique, which we can now so confidently claim, was not in the beginning an easy matter to attain.

The absolute smoothness with which the eventual large scale unit started was due to the vast amount of careful preliminary research and staff work which was undertaken.

The first building we erected was not a works nor an office, but a research laboratory; here every detail of the process was tested out on a scale sufficiently near to that of eventual manufacture to enable all necessary deductions to be drawn from it and sufficiently small to allow of easy and rapid alterations, al lour personel, managers, foremen, and workmen alike, were carefully trained on such plants.

As you go round the works to-morrow, you will probably be struck by the enormous number of measuring instruments employed. Lord Kelvin always said that the advance of science depended on exact measurement. In our case the maintenance of our industry depends on this. Many of our instruments are of novel type, and so great is the number required that we came to the conclusion that in the great majority of cases it would pay us to manufacture them, and we do so. During all the initial scientific and technical work, the economic side so vital to us and to you, was never forgotten, and a novel, flexible and original scheme of costing was introduced from the very start, and all our staff are trained with a proper balance between science, technique, and economics.

The success of any great enterprise depends upon the existence of a team spirit. Here not only is there manifested such a

spirit in a very high degree, but this is also scientifically organised. Thanks to the organising powers of my friend, Colonel Pollitt, a system has been evolved whereby even the latest joined recruit is not only encouraged but expected to put forward his views on any difficulty. This system of works governance has been so successful that it is spreading throughout our whole industry. Although the site is particularly favoured, we are for example breathing one of our raw materials and another exists in enormous quantities under my feet, we have nevertheless had to solve a vast general problem of internal organisation, repair, maintenance, etc., which to-morrow you will see for yourselves, and I venture to think that you will be impressed by its solution.

As you are aware, we have set ourselves the ambitious task of supplying the whole Empire with fertilisers, calculated to meet its vast varied and growing needs, and are not content to leave it at that. We have under the direction of my friend, Sir Frederick Keeble, a large experimental agricultural station of our own. We are anxious to co-operate with similar institutions throughout the Empire, and I would ask you to take this on your part as a cordial invitation to do so, and to assure you that any assistance such as in our power will be fully and freely offered to you.

I would like to say a few words on the importance of such an organisation as this to our national safety in time of war. The Great War was, as far as this country is concerned, fought out on Chili nitrate. Any failure on our part to maintain that long sea route would have meant irrevocable national disaster. The very processes used to convert nitrate of soda into explosives in the war, which as you are probably aware, were all worked out and carried through by this company, were difficult, trying to a degree in their initiation, and quite uneconomical. This state of affairs can never happen again. In the event of any future danger to the Empire, this organisation will have no difficulty in rapidly and economically producing the essential raw materials of explosives : ammonia and nitric acid.

Some of our other activities on this site have a great, though indirect, interest to agriculturists. The mechanism of agriculture is proceeding apace.

As you go through the works to-morrow you will be struck with the continuity and mechanised character of the processes employed. It may well happen that the chemical industry will be called upon to provide large centralised plants for agricultural operations, such as the drying and baling of grass, and if we ever were asked to do so, our general experience of the handling of materials of every description will be invaluable, and it is at your service."

(To be Continued.)

DETERMINATION OF SULPHUR TRIOXIDE IN THE PRESENCE OF SULPHUR DIOXIDE, TOGETHER WITH SOME ANALYSES OF COMMERCIAL LIQUID DIOXIDE.

By J. R. Eckman.

Associate Chemist, U.S.A., Bureau of Standards Scientific Paper.

Abstract.

A method for determining sulphur trioxide in sulphur dioxide has been developed for use in a study of the heat of formation of sulphur dioxide. It may find application also in control work in the manufacture of sulphur dioxide, sulphites, and sulphuric acid, and in the analysis of oxygen-free products of combustion of fuels. None of the methods given in the literature appeared suitable for the purpose. Therefore a method has been devised for the complete removal of sulphur trioxide by precipitation as barium sulphate in a slightly acid solution of barium sulphite, and filtration and washing of the precipitate with oxygen-free distilled water in an atmosphere of oxygen-free nitrogen. The method has been applied to the analysis of eight samples of commercial liquid sulphur dioxide.

Introduction.

The analytical method described in this paper was developed in connection with a study of the heat of formation of sulphur dioxide. It is published at this time on account of its possible application in control work in the manufacture of sulphur dioxide, sulphites, and sulphuric acid, and in the analysis of oxygen-free products of combustion of fuels. The literature contains a number of different methods which have been used for this determination. Berthelot in his work on the heat of formation of sulphur dioxide burned a definite amount of sulphur and absorbed the gas in the amount of iodine solution that would be required if all of the sulphur were burned to sulphur dioxide. Any unused iodine was

regarded as a measure of the sulphur trioxide present in the gas. Thomsen condensed the sulphur trioxide on the walls of the platinum combustion chamber, washed it out with water and titrated. Ljungh, using the principle of the Reich-Lunge method, determined dioxide plus trioxide by absorption in standard sodium hydroxide, and the dioxide by absorption in standard iodine solotion. Pellet absorbed the trioxide in concentrated hydrochloric acid and determined it gravimetrically by precipitation with barium chloride. Hawley used a sheet of filter paper moistened with water to collect the trioxide and then titrated the resulting sulphuric acid. Richter collected the trioxide in condenser tubes and determined it in the usual gravimetric way. Dunn investigated the Reich-Lunge method of estimating sulphur trioxide by difference and found it inaccurate. In his own method he absorbed trioxide plus dioxide in barium chloride solution contaning 10 to 15 per cent. of hydrochloric acid, removed the dioxide by boiling and determined the relative amounts of trioxide and dioxide by acid titration using double indicators. Sasder used standard sodium hydroxide as an absorbent for trioxide plus dioxide, added mercuric chloride to liberate a quantity of hydrochloric acid equivalent to the dioxide, and then titrated with standard sodium hydroxide. Gille collected the trioxide in a plug of cotton. Schmidt used as absorbents iodine solutions and varied the concentration for the purpose of getting selective absorption of the trioxide and dioxide.

None of these methods appeared suitable for the presest purpose and a method comprising the following essential features was accordingly devised. The sulphur trioxide is removed from the gas stream by means of a special filtering device; the sulphur trioxide is precipitated by a nearly saturated and slightly acid solution of barium sulphite which must be free from oxygen; and the barium sulphate is filtered and washed in an atmosphere of nitrogen free from oxygen. Various difficulties and sources of error involved in the earlier methods are thus eliminated.

Results.

The following eight samples of liquid sulphur dioxide from commercial sources were analysed :—

1. Specially purified and dried by fractionation.
2. Commercial product; partially purified and dried by fractionation.
3. Factory product; not fractionated to remove water.
4. Commercial product; dried with sulphuric acid.
5. Commercial product; dried with sulphuric acid.
6. Commercial product; dried with sulphuric acid.
7. Dried twice with sulphuric acid; slightly contaminated with oil from compressor during second drying.
8. Same as 7.

All samples were taken from 35-pound lots except sample 6 which came from a 5-pound cylisder. About 200 g was used for each determination and complete distillation required from 2¾ to 4 hours. In no case was any precipitate found in the analytical tube, showing the gas to be free from sulphur trioxide. Only in samples 3, 7, and 8 was any sulphur trioxide found in the residue. Results for the residue from sample 3 could not be checked and varied from a trace to 0.0032 per cent .of sulphur trioxide, isdicating non-uniformity of sample. In each of samples 7 and 8, 0.0011 per cent. of sulphur trioxide was found.

Summary.

1. A nearly saturated and slightly acid solution of barium sulphide free from oxygen is used as the reagent for precipitating sulphur trioxide.
2. A means is provided for filtering and washing the precipitated barium sulphate with oxygen-free distilled water in an atmosphere of oxygen-free nitrogen.
3. Results are given for eight different samples of commercial liquid sulphur dioxide.

THE CHEMICAL SOCIETY OF JAPAN.

Papers communicated :—

Juro Horiuchi : "A Relation between Orthobaric Densities."

Takeko Yoshida : "On the Electromotive Force and Solvents of Reversible Cells."

Shin-ichiro Hakomori : "On the Reaction of Hydrogen Peroxide with Some Metallic Ions. Potential of Hydrogen Peroxide."

Jun Yoshimura : "Chemical Investigation of Japanese Minerals Containing Rarer Elements. Part XI. Cathode Ray Luminescence of Fluorite, Ishigure, Ise Province.

REVIEW OF THE ELEVENTH EXPOSITION OF CHEMICAL INDUSTRIES. (NEW YORK.)

One of the most remarkable achievements in the history of industry has just been completed with the close of the Eleventh Exposition of Chemical Industries at the Grand Central Palace in New York City, where probably the greatest collection of the various chemical and allied industries in the history of the Exposition were assembled.

The Udylite Company exhibit of cadmium plating showed a metal resistant to sulphur fumes. The Matheson Company exhibited ethylene and other liquified gases and the distinctive feature of their exhibit was the demonstration of ethylene gas in hastening of ripened fruit colours on fruit. The American British Chemical Supplies Company showed a new plastic material produced from acetyl cellulose. And for the first time a large number of displays of fatty acids, waxes, glycerol and products made from there were shown.

Many new and outstanding developments in various by-products were exhibited. One of the most comprehensive displays of this nature was made by the Ford Motor Company By-Products Division. The model of the wood distillation plant created much favourable comment because of the detail in which it was constructed and the number of by-products produced, and the series of wood distillation products displayed by the Cleveland Cliffs Iron Company. The The Commercial Solvents Company exhibited synthetic methanol which has heretofore been a product essentially obtained from wood distillation which they have succeeded making sythetically and this was considered oue of the oustanding synthetic materials developed in this country. Among new machinery exhibits were a cantilever filter by the United Filter Company and an interior filter shown for the first time by the Dorr Company, both of which are of great importance in the filtration field. The drying machinery opened up some very new developments, among which were the exhibits by the Gordon Davis Engineering Company and James Hunter Machine Company.

The strides taken in the development of machinery used in handling metalliferous ores is one that has taken long strides. Among the crushers were the Hardinge Company's conical ball mill, and a type of rod mill which are adapted to an enormous range of uses in general industry. The Abbe Engineering Company who for years have been among the leaders in the ball mill grinding field had a fine exhibit. The Bethlehem Steel Company's pulveriser which dates far back of any metallurgical operation in Chile and is a revival of the Chilean mill and its principal features are the revival of the skilled workmanship of the rolls and the methods of handling the raw materials. The various screening processes by the W. S. Tyler Company, Niagara concrete Mixer Company, Norwood Engineering Company, Orville Simpson Company, C. W. Hunt and Company, and the Traylor Vibrator Company created much favourable comment and are of great importance in the chemical and mining industries. The exhibit of the Western precipitation Company, of the Cottrell system of air cleaning by electrical precipitation was one of the greatest of its kind. In the Sontaiser Section, the Pressed Steel Tank Company exhibited for the first time a Monel metal tank used for the transportation of nitric acid. This was considered one of the most interesting and useful exhibits in the Show. The Wheeling Corrugated Steel Company's new corrugated drum and barrel which they manufactured on the premises secured very favourable consideration from representatives of the industry. The Carpenter Container Company with its new fabricated barrel and drum, obtained many interested visitors during the week.

The new Vorce cell shown by the Electro-Chemical Engineering and Supply Company which is as entirely new process for making chlorine and soda, was one of the greatest features of the Exposition and was shown for the first time, creating a great deal of favourable comment by engineering authorities and visitors. Among the oldest manufacturers of silver salts in the United States who exhibited for the first time was Phillips and Jacobs, along with the Standard Calorimeter Company showing Parr calorimeters. Bausch and Lomb Optical Compasy showed a number of new optical instruments for the first time, developing a great deal of interest among the visitors to the chemical industry. General Electric Company's hydrogen welding process, using an electric spark as the heating element for hydrogen welding, received much favourable comment by the visitors. Another exhibit of great interest was that of vitaglass which transmits actinic or ultra violet ray, which is life and health giving, and is a development of the chemical industry. Miner Laboratories' display

of Furfural and its derivatives and by-products with a new development for electrolytic engraving, was of equal importance to the visitors.

Various exhibits in the Southern Section by the Southern Railway Company, The Alabama, Birmingham and Coast Railway, and the Southern Parific Lines, contained exhibits of raw materials useful in the chemical industries throughout the country. The Canadian Section and the Ontario Department of Mines covered a wide range of products and raw materials that were decidedly interesting and well displayed. The various metals and their treatments were among the prominent features and carried many interesting developments. The various casein exhibits along with the synthetic resins proved interesting and instructive in one of the largest and most diversified exhibits of the kind displayed.

The Government's exhibits were probably the finest ever sent any exposition, and contained some extremely valuable data in the fertiliser sections and nitrate division. The exhibitors of instruments of precision contained some of the latest processes and practices as used in the chemical industries.

An outstanding accomplishment was the Students' Course under the Chairmanship of Professor W. T. Rear, Head of the Department of Chemistry at the Texas Technological College, Lubbock, Texas. Over one hundred and sixty students enrolled for the course. One hundred and two were students from various educational institutions and the others were professors, engineers and representatives from industry sent by their respective organisations for the purpose of takin gthe course. The work of all students will be closely scrutinised and credit given for all work.

After the discussion a general inspection was made and actual demonstration of various processes explained. The lectures during the course were given by outstanding in each particular case. The student's programme carried a most comprehensive group of subjects.

NORWEGIAN AGRICULTURE.

Out of the total area 70 per cent. is mountainous and unproductive, 22 per cent. is wooded and only 3.5 per cent. (about 1,675,000 acres) is under cultivation. The cultivated area includes 639,000 acres of arable land, the remainder being meadow land. There are also 681,000 acres of natural pasture.

GENERAL NOTES.

HEALTHFUL GAS FIRES.

Popular Fallacy That Led To Improvements in Domestic Heating.

"As a result of our spectroscopic examinations we have been able to effect changes in our gas fires by which there have been improvemeuts in the quality of the energy they emit. Such improvements have been confirmed by observation of the effect of the energy on the human body."

This statement was made by Dr. Harold Hartley, Chief Chemist to the Radiation Laboratories, in the course of a lecture before the Scottish Junior Gas Association at Edinburgh on Saturday, October 15.

"It is doubtful" said Dr. Hartley in an earlier part of his address, "whether those who have not actually been associated with the development of the gas fire realise what a large amount of work is at the back of the present-day appliance. Changes in design have not been made haphazard, and many of them represent the application of results attained in the laboratory.

"During the present century the principal changes that have been effected in the gas fire have been introduced with the following objects :—

(1) To satisfy the requirements of hygiene with especial reference to the removal of the product of combustion and to the promotion of ventilation.
(2) To improve upon the combustion of the gas.
(3) To make the appliance silent in operation.
(4) To increase thermal efficiency.

The lecturer traced the history of gas fire design from the days of the old ball fuel appliance, which was made to present a bright, incandescent appearance, but which possessed low heating power and other drawbacks, to the efficient hygienic apparatus of the present day. The idea that the gas fire dried the air of the room and could, as many users imagined, be corrected by placing a bowl of water in front of it was not, he said, in accordance with scientific fact. It showed, however, that the public was not satisfied with the old-fashioned appliances, and led to better ventilation of the room and other important improvements.

EMPLOYMENT IN CANADA AND THE U.S.A.

According to the Royal Bank of Canada on August 1st, 1927, the Dominion Bureau of Statistics index number of employment for all industries reached 109.2,—a new high level; the index of employment in manufacturing reached 98.9, the highest point since 1920. It is interesting to note that new high levels have also been attained recently in the employment indices for mining, transportation, construction, service and trade. On July 1st, 1927, the United States Bureau of Labour Statistics index of employment stood at 89.1.

THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

30, Russell Square, London, W.C.1.

SEPTEMBER EXAMINATIONS, 1927.

PASS LIST.

Examination in General Chemistry for the Associateship.

Macadam, George Herbert, B.A. (Cantab.) (Cambridge University); Osborn, Harry William Leonard, (Sir John Cass Technical Institute, London; and Northern Polytechnic, London); Smirles, William Nelson, B.Sc. (Lond.) (Birmingham Central Technical College); Smith, Arthur, B.Sc. (Lond.) (Trained under G. E. Johnson, B.Sc., F.I.C., at Hull Municipal Technical College; Wilson, Herbert Newton (Trained under the Chief Chemist, Messrs. Sadler & Co., Middlesbrough; and under the Head of the Chemistry Dept., Darlington Technical College).

Examinations for the Fellowship:

In Branch D: Biochemistry, with Special Reference to the Hormones:

Fuller, Albert Thomas, Ph.D. (Lond.).

In Branch E: The Chemistry (including Microscopy) of Food and Drugs, and of Water:

Jones, Henry Humphreys; Trace, Leslie Herbert, B.Sc. (Lond.); Turner, Charles Frederick.

In Branch G: Industrial Chemistry with Special Reference to Petroleum Technology:

Kelly, Charles Ignatius, M.Sc.Tech. (Manc.).

Chemical Technology of Textiles:

Jackson, Stanley Ridings, B.Sc.Tech. (Manc.).

Special Examination in General Chemistry:

Beaumont, Glynne Wentworth.

AMERICAN POWER AND LIGHT INDUSTRIES.

A feature of the electric power and light industries has been the rapid expansion in the production of current and a very large increase in the number of consumers. Wages in electricity plants, as compared with 1914, were 118 per cent. higher in January last.

INCREASE IN SHIPBUILDING.

Plans passed by the Committee of Lloyd's during the year ended with June last represent a greater amount of construction than in any corresponding twelve months since 1920. It is still more encouraging to note that over 66 per cent. of the projected tonnage is to be built in Great Britain and Ireland.

IMPORTED FRESH APPLES AND PEARS.

The Public Enquiry into the application for an Order-in-Council under the Merchandise Marks Act, 1926, to require the marking of imported fresh apples and pears will be held in Room 104, at 10, Whitehall Place, London, S.W.1., commencing at 10.30 a.m., on Tuesday, 15th November, and continuing, if necessary, at the same time on the following day.

Applications to be heard in evidence and any other communications with regard to the matter should be addressed, as early as possible, to the Secretary of the Standing Committee, Mr. H. J. Johns, 10, Whitehall Place, London, S.W.1.

EUROPEAN SUGAR PRODUCTION.

The British Commercial Secretary at Prague informs the Department that, according to the *Prager Presse*, the "English demand for Czechoslovak refined sugar has fallen markedly for the present and is not expected to revive before December."

Figures published in the *Narodni Listy*, following results of detailed investigations by the International Society for Sugar Statistics in Vienna, of the probable estimates of this year's sugar beet and sugar production in European countries, gives the numbers of factories at work this year as 646, or 20 more than a year ago, while European sngar production is estimated at 409,000 tons (or 9.1 per cent.) higher than last year at 4,885,000 tons. The increase is largest in Czechoslovakia, which will produce this year some 142,000 tons more (13.6 per cent.), than in 1926.

ROYAL INSTITUTION.

The Tyndall Lectures at the Royal Institution will be delivered this year by Sir Herbert Parsons on Light and Sight commencing on Tuesday November 1, at 5.15 p.m. On Thursday November 3, at the same hour Mr. H. Clifford Smith will the first of two lectures on The Furniture and Equipment of the Mediaeval House, and on Saturday November 5 at 3 o'clock Mr. Emile Cammaerts begins a course of two lectures on the Main Features of Modern English Literature.

LOUGHBOROUGH COLLEGE.

Leicestershire, England.

OPEN SCHOLARSHIPS IN ENGINEERING.

The College Governors invite applications for the award of five open scholarships in the Faculty of Engineering, each of the value of £75 per annum. The Scholarships are open to British Subjects situate in any part of the Empire, and are tenable at Loughborough College, Leics., England, for the period of the full diploma course.

The entrance examination for the Session 1928-29 will take place on Tuesday, Wednesday, and Thursday, 24, 25 and 26 April, 1928. All applicants must be not less than 16 years of age on 1 Ostober, 1928.

Candidates resident in the United Kingdom will be required to attend at Loughborough. Candidates resident in other parts of the Empire will be examined on the dates named at local centres where recognised facilities are available, and have been approved by the College Governors.

Further particulars and application forms may be obtained from the College Registrar, to whom all forms of application must be returned not later than the 1 April, 1928.—H. SCHOFIELD, Ph.D., B.Sc. Hons. (Lond.), Principal of the College.

THE BRITISH SCIENCE GUILD.

The third annual Norman Lockyer lecture "Scientific Ethics" will be given by the Very Rev. Dean Inge, C.V.O., D.D., on Monday, 21 November, 1927, at 4.0 p.m., in the Goldsmiths' Hall, Foster Lane, E.C.2., by courtesy of the Goldsmiths' Company. The President of the British Science Guild, the Rt. Hon. Sir Alfred Mond, Bart., M.P., will take the Chair.

Admission to the lecture is free, and tickets may be obtained on application to the Secretary, The British Science Guild, 6. John Street, Adelphi, London, W.C.2.

ELECTRICAL CONDUCTIVITY OF BORAX.

By SOJIRO OKA.

The change of electrical conductivity of borax from the molten state to the glass state was investigated. The conductivity cell was composed of two concentric platinum vessels of crucible shape, which served as electrodes as well as the container of borax. A pair of thick platinum wires were attached to each of the vessels and served as lead for electricity as well as for suspending the vessel and keeping it in position. Borax was put in the annular space made between the two vessels. The amount of the charge was fixed by the height of rim of the inner, smaller vessel; borax is charged so much that some of it flew over the rim into the inside of the inner vessel, where the end of a thermocouple was placed. The whole was heated in a vertical electric furnace. The cell constant at ordinary temperature was determined with aqueous potassium chloride solution. The constants at higher temperatures were calculated from it with the known coefficient of expansion of platinum. The conductivity was measured with usual telephone method.

The specific conductivity, k, of the molten borax was found to be much less than those of most of the other molten salts, for instance $k \times 10^3 = 155$ at 800° C., 71 at 700° C., 17.5 at 600° C., and 1.76 at 500° C. No break point was found in the conductance-temperature curve at the temperature that corresponded the melting point. Borax at lower temperatures was in state of glass. In the diagram of log k against 1/T, a straight line of the type, $\log k = A/T + B$, was found connecting the points found between 660-480° C., from the molten to the glass state, and the points of the lower temperatures were on another similar straight line. The two intersected at about 480° C., but the meaning of this point remains still unknown.—*Department of Applied Chemistry, Faculty of Eng., Tokyo Imperial University.*

LETTERS, ETC., FOR LOURENCO MARQUES.

The British Consul-General at Lourenço Marques informs the Department that the Post Office of Portuguese East Africa has intimated that letters ,etc., intended for Lourenço Marques, but incorrectly addressed "Delagoa Bay," will in future not be delivered, but will be returned to the senders.

CORRESPONDENCE.

LINTHICUM FOUNDATION PRIZE.

(*To the Editor of the* CHEMICAL NEWS.)

Dear Sir,

Your attention is invited to the Charles C. Linthicum prize of $1,000.00, and a medal, offered for the best monograph on the law of "Scientific Property," *i.e.*, the extension of the patent or copyright laws so as to recognise a right, in the discoverer of a scientific principle, to some share of the profits that may accrue to an inventor who makes use of that discovery to devise an "art, machine, manufacture, or composition of matter" (as statute defines it) and thus obtains a patent. The law has hitherto not recognised such a right.

This subject has of late years received wide attention in Continental Europe. But as yet, in the country which excels in inventions, it has received no attention at all. It is a coming theme of extraordinary importance; and the lawyers of our country ought to be forming their opinions on this subject. Our object is to stimulate a wide interest among lawyers.

Your periodical will reach many persons engaged in scientific work. They may not be qualified to compete for the prize, but they can call the attention of their legal friends to the subject and invite their interest.

Very truly yours,
JOHN H. WIGMORE,
(*Dean of the Faculty of Law.*)

Northwestern University School of Law,
McKinlock Campus, Chicago,
Illinois.
October 6, 1927.

DYE-POLISH QUERY.

(*To the editor of the* CHEMICAL NEWS.)

Dear Sir,

In connection with the development of a local industry, I am desirous of securing a little information on the following:—Having devised a means of simultaneously dyeing and saturating with raw linseed oil certain wood articles (the wood articles in question being in a very hard state by means of compression) is it possible to employ some kind of relative agent that will readily mix with the linseed oil and at the same time add weight to the article so treated in bulk? Also, is there any means whereby the same mixture of added agent and linseed oil could also in addition have an additional agent employed that would leave the article (when withdrawn from the mixture and dried), with a highly polished or glossy finish? Briefly, to dye, saturate with oil, add weight, and appear highly finished, all by the one process of immersion. I am uncertain whether you answer queries of this description by direct letter or through the columns of the *Chemical News*. I shall be grateful if you will put me in the right channel for securing the above information.

Yours, etc.,
J. T. MARSH.

295, Huntlands,
Green Mount,
Nr. Bury, Lancashire.

THE ROYAL SOCIETY.

ORGANISERS IN ANIMAL DEVELOPMENT.

This was the subject of the Croonian lecture delivered before The Royal Society on November 3, by Prof. Hans Spreeman Frieburger.

The conception of "organisers in development" has been derived from experiments in amphibian embryos in the earliest stages. The different regions of such an embryo have not the same value for development; most of them are relatively indifferent and do not carry their destiny in themselves. This could be shown by transplantation of these parts into other regions of the embryo; they follow the development of their new environments.

But there is a certain region in the embryo, parts of which behave in a perfectly different manner. Transplanted into an indifferent region of the embryo, they do not adapt themselves to their new environment, but retain their own character, and force, as it were, the others to follow them. Such parts organise a new embryo, which is built up partly by the transplanted cells, partly by the cells of the host. Therefore they are called "organisers," and the region where they lie together in those early stages of development the "centre of organisation."

Further experiments have been made to determine the extent of this centre, it origin, its intimate structure and the nature of the organising influence.

FORTHCOMING EVENTS.

Monday, November 7.

INSTITUTION OF ELECTRICAL ENGINEERS.

At 7 p.m.—Wireless Section. "Recent Developments in Electro-Medical Appliances," by Mr. C. H. Holbeach.

Mersey and N. Wales Section, at the Laboratories of Applied Electricity, Liverpool University. "The Application of Electricity in War Ships," by W. McClelland, C.B., D.B.E.

UNIVERSITY COLLEGE.
Gower Street, London, W.C.1.

At 5.15 p.m.—The Gow Lectures: "The Colloid Chemistry of the Rubber Industry." First of a Course of Six Public Lectures by Dr. E. A. Hauser. November 7, 9, 11, 14, 16 and 18. (Lantern Illustrations.)

Tuesday, November 8.

INSTITUTION OF ELECTRICAL ENGINEERS.

At 7.30 p.m.—Scottish Centre, at the Royal Technical College, Glasgow. "The Appliance of Electricity in Warships," by W. McClelland, O.B.E.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

At 5.30 p.m.—At the Royal Society of Art Rooms, John Street, Adelphi.

OIL AND COLOUR CHEMISTS' ASSOCIATION.

At 8 p.m.—At the National Federation of Paint Manufacturers, 8, St. Martin's Place, London, W.C.2. "The Scattering of Light by Suspended Particles," by Prof. T. M. Lowry, C.B.E., F.R.S.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

At 5.30 p.m.—At the Royal Society of Arts Rooms, John Street, Adelphi.

Wednesday, November 9.

INSTITUTION OF ELECTRICAL ENGINEERS.

At 7 p.m.—South Midland Centre, at the University, Edmund Street, Birmingham. "The Economic Aspect of Pulverised Fuel," by Prof. A. W. Nash. "Coal Analysis in Relation to Heat Value for Raising Heat," by Prof. K. N. Moss, M.B.E.

ROYAL SOCIETY OF ARTS.
John Street, Adelphi, London.

At 8 p.m.—Mervyn O'Gorman, C.B., D.Sc., M.Inst.C.E.: "Road Traffic Problems of the Pedestrian." The Hon. Sir Arthur Stanley, G.B.E., C.B., M.V.O., LL.D., Chairman, Royal Automobile Club, will preside.

UNIVERSITY COLLEGE.
Gower Street, London, W.C.1.

At 5.30 p.m.—"Regions and Place-Names in Norway." First of a Course of three public lectures by Mr. I. C. Gröndahl. November 9, 16, and 23. (*Lantern Illustrations.*)

ROYAL INSTITUTE OF PUBLIC HEALTH.
37, Russell Square, London, W.C.1.

At 4 p.m.—"The Present Situation as Regards Housing," by Lt.-Col. F. E. Fremantle, O.B.E., M.D., M.P.

INSTITUTE OF METALS.

At 7 p.m.—Swansea Section, at Thomas Cafe, High Street. "Pyrometers in Works Practice," by Peter McNair, Ph.D.

Thursday, November 10.

THE ROYAL SOCIETY.

At 4.30 p.m.—C. D. Ellis and W. A. Wooster: "The Average Energy of Disintegration of Radium E." Communicated by Sir Ernest Rutherford, P.R.S.

E. T. S. Appleyard and H. W. B. Skinner: "On the Excitation of Polarised Light by Electron Impact. II. Mercury." Communicated by Sir Ernest Rutherford, P.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS.

At 7.30 p.m.—Dundee Sub-Centre, at the College, Dundee. "Electrical Repairs to Motors and Dynamos," by A. S. McWhirter.

UNIVERSITY COLLEGE.
Gower Street, London, W.C.1.

At 5.30 p.m.—"More London Place-Names." First of a course of Five Public Lectures by Miss E. Jeffries Davis. November 10, 17, 24, December 1 and 8.

ROYAL INSTITUTION.
Albemarle Street, London, W.1.

At 5.15 p.m.—"The Furniture and Equipment of the Mediæval House," by H. Clifford Smith, M.A., F.S.A.

THE OPTICAL SOCIETY.

At 7.30 p.m.—At the Imperial College of Science and Technology, South Kensington.

INSTITUTE OF METALS.

At 7.30 p.m.—At 83, Pall Mall, S.W.1. "Some Metallurgical Problems of the Chemical Industry," by C. C. Paterson, O.B.E.

Friday, November 11.

ROYAL SOCIETY OF ARTS.

At 4.30 p.m.—Indian Section. " Indigenous Banking in India," by M. M. S. Gubbay, C.C.S.

THE PHYSICAL SOCIETY.

At 5 p.m.—At the Imperial College of Science and Technology, Imperial Institute Road, South Kensington, London.

Saturday, November 11.

ROYAL INSTITUTION.

Albemarle Street, London, W.1.

At 3 p.m.—" The Main Features of English Literature," by Emile Cammaerts, C.B.E., F.R.Hist.S.

U.S.A. OFFICIAL PUBLICATIONS RECEIVED.

DEPARTMENT OF THE INTERIOR.

Surface Water Supply in 1923 *of the Colorado River Basin.* Part IX.

Part XII. *North Pacific Slope Drainage Basin.*

Geology and Ore Deposits of the Mogallon Mining District, New Mexico. (With several maps.)

Correlation of Geologic Formations between East-Central Colorado, Central Wyoming and Southern Montana. (With numerous illustrations.)

The Geology of Vernon Country. Vol. XIX. Second Series. Illustrated.

DEPARTMENT OF COMMERCE.

Determination of Sulphur Trioxide in the Presence of Liquid Sulphur Dioxide.

Transmission of Sound through Building Materials.

Application of the Algebraic Aberration Equations to Optical Design.

U.S.A. Government Master Specification for Ribbons, Computing and Recording Machines; Ribbons, Hectograph; Ink, Drawing, Black Waterproof.

Alphabetical Index and Numerical List of U.S. Government Master Specifications, promulgated by the Federal State Board.

Effect of Laundering upon Thermal Insulating Value of Cotton Blankets.

Study of the Windows of Window Envelopes for the purpose of Developing Standard Specifications..

Determination of Weight per Gallon of Blackstrap Molasses.

Standard Sample General Information.

Absorption Spectra of Iron, Cobalt, and Nickel.

Calibration of a Divided Scale.

Testing of Measuring Tapes at the Bureau of Standards.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

27,330.—Daudt, H. W.—Production of tetra-alkyl lead. October 14th.

27,441.—Feige, R.—Apparatus for carrying out chemical reactions. October 15th.

27,200.—I. G. Farbenindustrie Akt.-Ges.—Production of hydrocyanic acid. October 13th.

26,928.—Selden Co.—Contact sulphuric acid process. October 11th.

26,935.—Soc. Anon des Distilleries des Deux-Sevres.—Separation of fatty acids. October 11th.

Specifications Published.

278,444.—Stickings, R. W. E. and May & Baker, Ltd.—Manufacture of organic compounds or arsenic.

255,876.—Demann, W.—Process and apparatus for neutralising ammonium sulphate crystals.

276,295.—Lilkenroth, F. G.—Method of oxidising ammonia by means of oxygen.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

276,659.—Sulphuric Acid.—Petersen, H., 6, Hohenzollernstrasse Steglitz, Berlin.

Tower Processes.—In the manufacture of sulphuric acid by tower process ,such as the Opl process ,almost the whole of the nitrous oxides are set free in the first production tower. This is accomplished by the use of a tower of large dimensions irrigated intensively with nitrated acid. The tower may be fitted with atomisers, washers, rotary mixing-devices, etc., or may be packed with acid-resisting grains having a diameter of about 40 mms.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

HARLEQUIN.

483,545.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—J. E. Ellis, Ltd., Lister Laboratories, Station Road, Horsforth, near Leeds. October 12th.

MONSOLA.

483,675.—Chemical substances in class 2 used for agricultural, horticultural, veterinary and sanitary purposes.—The Mond Staffordshire Refining Co., Ltd., 47, Victoria Street, London, S.W.1. October 12th.

METACAIN.

483,901.—Chemical substances prepared for use in medicine and pharmacy.—Chemical Works, formerly Sandoz, 60, Fabrikstrasse, Basle, Switzerland.

MIGEX.

470,578.—A Chemical Preparation for personal use to prevent the bites and stings of Insects.—Penny & Co., Ltd., 16 & 18, Beak Street, London, W.1. October 19th.

479,921.—Illustration of a Globe, with the words " Per Totum Cogniti," written on a scroll and a Monogram WLU, for chemical substances prefor use in medicine and pharmacy.—Wright, Layman and Umney, Ltd., 44 to 50, Southwark Street, London, S.E.1. October 19th.

483,598.—Illustration of a Kagu Bird, and the word " KAGU," for chemical substances prepared for use in medicine and pharmacy. — Constance-Moore-Blunt, 54, St. Stephen's Road, Norwich. October 19th.

GENERAL INDEX TO THE " CHEMICAL NEWS "—VOLS. 1 TO 100.

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THE CHEMICAL NEWS

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THE HISTORY OF WITHERITE.

By G. FOWLES, M.Sc., A.I.C.

It is usually stated in treatises on chemistry that witherite (native barium carbonate) was discovered by Dr. Withering on the Lead Hills (or at Leadhills) in Scotland in 1783. Thus such a statement appears in all editions of Roscoe and Schorlemmer, in Thorpe's *Dictionary of Chemistry*, and in the modern comprehensive treatises of Friend and Mellor. But in works on mineralogy another locality is given for the discovery of witherite: according to Aikin's *Dictionary of Chemistry and Mineralogy*, 1807, Vol. ii., p. 490, the mineral described by Withering came from Anglezark in the north of Lancashire; a similar statement appears in *Mineralogy* by Miers, 1902, p. 410. Now it is obvious that both localities cannot be correct, and if Withering's own paper is to be taken as the authority (*Phil. Trans.*, 1784, 74, 293), and I cannot find that he ever amended it, then both are wrong, for he twice states that the mineral he examined came from a lead mine at Alston Moor in Cumberland.

At first, from its calcareous appearance, its density (4.3), and its irreducibility, Withering considered the mineral a specimen of the then well-known spatum ponderosum (heavy spar, $BaSO_4$), but later, on making a closer examination, was delighted to find that what he had discovered was the compound of *terra ponderosa* (BaO) and fixed air (CO_2) whose existence had been predicted by Bergman. Withering called the substance of his mineral "*terra ponderosa aërata*," Scheele having given the name *terra ponderosa* to the earth he obtained from heavy spar: *terra ponderosa* was changed to baryta a few years later by Lavoisier, and in 1790 A. G. Werner suggested the name witherite for the naturally occurring form of terra ponderosa aërata.

Withering obtained a solution of terra *ponderosa* by dissolving his mineral in marine acid (HCl), re-precipitating it with mild fixed fossil alkali (Na_2CO_3), subjecting the precipitate to a fierce heat (although he does not explicitly say so, it is apparent from his paper that he used a charcoal crucible, which would facilitate the decomposition, which, without the catalyst is a difficult operation) and digesting the product with water. A strong solution of what Withering called "a lime" was thus produced. He showed that this lime closely resembled in chemical properties the ordinary calcareous earth (lime), but differed from it in that it gave an immediate precipitate (even if enormously diluted) with a drop of vitriolic acid (H_2SO_4): that "its gypsum" was insoluble: and that its nitrate and chloride were stable salts whereas those of ordinary lime were deliquescent.

To show that the oxide in the *terra ponderosa aërata* was identical with that in *terra ponderosa vitriolata* (heavy spar) some of the newly described mineral was converted into the latter by dissolving it in marine acid and then adding vitriolic acid. The product thus obtained was shown to have properties identical with those of heavy spar: each was found to be insoluble in all acids except boiling concentrated

vitriolic acid, and to be precipitated from this solution on the addition of water. For the purpose of this comparison Withering obtained a specimen of heavy spar from the Kilpatrick Hills near Glasgow and this is the only mention of Scotland in his paper.

Since Alston Moor is on the Pennines and lead occurs there, it would appear that the lead hills are those of England and not of Scotland.

ELECTROLYSIS OF COPPER PYRITES.

By Robert Saxon, B.Sc., F.C.S.,

Member of the American Chemical Society.

From a great number of attempts to bring down the copper from copper pyrites it seems extremely probable that the iron cation holds the copper along with the sulphur as anode. The iron comes away more freely under the influence of electrolysis from copper pyrites than from iron sulphide, although copper is less basic. Ferro ferricyanide and ferri ferrocyanide yield iron rapidly with water alone until the basic iron has been rendered as hydroxide and then the iron from the original anion. It would be a delicate test of double salts to see which base came down first under extremely weak voltages. That which did so would probabdly in every case be the base which held the accompanying " base " along with and part of the anion.

Salts of lead have been tried with copper pyrites as electrolyte to woo away the sulphur from the ore. A considerable amount of lead sulphide is obtained as nitric acid as test turns such to white sulphate. The cathode dipped into strong acid lets fall a shower of white lead sulphate. There is certainly a little sulphuretted hydrogen given off but not enough as gas or in solution to account for the sulphide.

Lead chloride gives deposit of lead sulphide, lead and lead chloride, with ferric hydroxide, but no detectable copper. The deposit of lead sulphide increases as the heat engendered dissolves more chloride to be decomposed in favour of the more insoluble sulphide. The residual ore roasts more readily to the oxides of copper and iron than the original did. The current gives it a looser texture. The green colour of parts are not chloride or sulphate for these would dissolve and decompose. They are probably due to sulphides other than the ordinary compound. The heating of copper in air gives rise to similar colours due probably to oxides other than the monoxide.

As electrolyte ammonium and sodium or potassium chloride give good results. Their chlorine prevents the destruction of a carbon anode. After the lead chloride begins to dissolve freely they remain constant there being little or no hydroxide ,but there is in every case the formation of yellow salts whose colour is not due to free chlorine, but possibly polysulphides. These do not disappear with washing ,but on evaporation and only when heated to drive away the last traces of chlorine or water does the colour begin to disappear.

SOME REFLEXIONS ON THE PROPERTIES OF THE ELEMENT OF ATOMIC NUMBER 87 (DVI-CAESIUM, Dc. 224)

By D. K. Dobroserdov. (Odessa).

In 1871, Mendelejev predicted the existence and discovery of several previously unsuspected elements which would occupy the blank spaces in his periodic classification of the elements. A number of these were subsequently discovered but a few remain which have not yet been isolated, and among them is the element dvi-caesium, designated according to Moseley's scheme as the element of atomic number 87, and for which the name Russinm, Rs, is proposed.

Dvi-caesium is expected to be radio-active and it is suggested that the so-called feeble radioactivity of potassium and rubidium is due to the admixture of traces of compounds of dvi-caesium among the salts of K and Rb. This assumption, it is pointed out, would account for the fact that potassium is essential to plant and animal life. The presence of dvi-caesium in sylvine and other potash minerals and rocks may well be responsible for their emission of β-rays and for the accumulation of helium in such bodies. Dvi-caesium should be sought in specimens which show the greatest β radiation and have the largest helium content. Little indication of the existence of dvi-caesium has been obtained by spectral research but the use of the mass spectrograph should reveal its occurrence in enriched specimens from potassium preparations.—Abstracted from *J .Chem. Soc., Ukraine*, 1925, Vol. I., book 4, p. 491.

SALTS OF ALPHA LINOLIC TETRABROMIDE (SODIUM, POTASSIUM, ZINC, BARIUM, CALCIUM, AND STRONTIUM) FROM PHILIPPINE LUMBANG OIL.

By ADELAIDA T. ORETA (Assistant in Chemistry, University of the Philippines), AND AUGUSTUS P. WEST (Professor of Chemistry, University of the Philippines).

(Abstract from the Philippine Journal of Science.)

Recent experiments indicated that Philippine lumbang oil contains various linolic glycerides corresponding to different linolic acids. These glycerides, together with linolenic glyceride, are the principal substances tbat absorb oxygen from the air and cause the oil to dry. Alpha linolic glyceride is perhaps the most important of the linolic glycerides. This glyceride and the corresponding free alpha linolic acid are, therefore, substances of considerable importance. Although the glyceride and the free acid are substances that oxidise readily, they may be separated from an oil in the borm of a stable tetrabromide.

$$CH_3(CH_2)_4\overset{Br}{\underset{|}{C}}H\text{-}\overset{Br}{\underset{|}{C}}HCH_2\overset{Br}{\underset{|}{C}}H\text{-}\overset{Br}{\underset{|}{C}}H(CH_2)_7COOH$$

Since this crystallised alpha linolic tetrabromide is a stable form of the alpha linolic compounds, it is an important substanee in the chemistry of vegetable drying oils. Only a very few derivatives of this substance (alpha tetrabromide) have ever been prepared and, in view of this fact, it seemed desirable to make a few salts of this substance and determine their solubility in various organic solvents. The data thus obtained may be useful in devising new methods for separating mixtures of various linolic tetrabromides.

EXPERIMENTAL PROCEDURE.

Preparation of alpha linolic tetrabromide.—Philippine lumbang oil was used as the material for preparing a supply of alpha linolic tetrabromide. Lumbang oil is obtained from the seeds of *Aleurites moluccana*. It is a drying oil and is used in making paints, varnishes, and similar products. The lumbang was pressed from seeds of good quality and filtered, first through glass wool and then through filter paper. Lumbang oil consists almost entirely of the unsaturated glycerides of linolenic, linolic, and oleic acids.

The alpha linolic tetrabromide was prepared from lumbang oil in accordance with the procedure adopted by Santiago and West in a recent investigation of lumbang compounds. The lumbang oil was saponified with aldehyde-free alcoholic potassium hydroxide. The mixed potassium soaps thus obtained were converted into the mixed acids. The mixed acids were brominated in ether solution, according to the procedure used by Imperial and West in preparing linolenic hexabromide. The ether solution of mixed acids was stirred mechanically by means of a hot-air motor and brominated at -10° C. The insoluble linolenic hexabromide was removed by filtering. The ethereal filtrate from the hexabromide was treated with sodium thiosulphate solution to remove the bromine, dehydrated with sodium sulphate, and distilled to eliminate the ether. The residue was treated with cold petroleum ethe which precipitated a mixture of linolic tetrabromides. The crude solid tetrabromides were separated from the oily (gamma) tetrabromide and oily oleic dibromide by filtering. The crude crystalline tetrabromides were washed with petroleum ether, after which they were crystallised from ethyl alcohol (95 per cent). Two crops of impure alpha linolic tetrabromide (melting point 110 to 113° C.) were obtained. The crude apha tetrabromide was washed again with petroluem ether and crystallised once from gasoline and several times from ethyl alcohol. After this further purification the melting point was 112.3 to 114.3° C.

Salts of alpha linolic tetrobromide were prepared by first converting the acid into potassium salt. An alcoholic solution of the K salt was then treated with an inorganic salt, such as zinc chloride. The precipitated salt thus obtained was purified and the melting point and solubitity in various solvents were determined. The solium and potassium salts were, however, prepared directly from the free alpha linolic tetrabromide. In preparing these salts ethyl alcohol (95 per cent.) was used as a general solvent.

Potassium salt of alpha linolic tetrabromide.—Thirty-five grams of alpha linolic tetrabromide were dissolved in about 600 cubic centimeters of hot ethyl alcohol (95 per cent). To this alcoholic solution there was added from a burette an excess of the calculated amount of half normal alcoholic potassium hydroxide solution prepared with aldehyde-free alcohol. The potassium salt of the alpha linolic tetrabromide was formed as a while, gelatinous precipitate which dissolved when the mixture was boiled.

The mixture was heated (reflux) on a water bath for about five hours. When the mixture was cooled the potassium salt was separated out and was removed by filtering. The potassium salt was crystallised once from methyl alcohol and once from ethyl acohol. It was then placed on a watch glass and dried in a vacuum desiccator.

Analysis :

	Bromine. Per cent.
Calculated for $C_{18}H_{31}Br_4O_2K$	50.10
Found	50.13

Zinc salt of alpha linolic tetrabromide.—Eight grams of alpha linolic tetrabromide were dissolved in about 200 cubic centimeters of hot ethyl alcohol (95 per cent). To the hot clear solution was added with shaking a slight excess of the calculated amount of half normal alcoholic potassium dhyroxide solution. The mixture was heated (reflux) on a water bath for about two hours and then treated with a slight excess of the calculated quantity of hot alcoholic zinc chloride solution (0.9287 gram of zinc chloride dissolved in 150 cubic centimeters of ethyl alcohol). A white flocculent precipitate of the zinc salt of alpha linolic tetrabromide was formed. The mixture was heated (reflux) on a water bath until the alcohol above the precipitate was completely clear indicating that the reaction was complete. This required about seven hours. The mixture was cooled and filtered. The precipitate was washed several times with ethyl alcohol to remove any unchanged alpha linolic tetrabromide, and with ethyl alcohol (50 per cent.) until the washings gave a negative test for chlorides. After washing again with a small quantity of ethyl alcohol (95 per cent.) the product was dried in an oven at 60° C., and then placed in a vacuum desiccator.

The melting point determination showed that the salt began to melt at 154.7° C., and melted completely at 158.8° C. without turning brown.

The formula of the salt was checked by determining the zinc as zinc oxide. A weighed quantity of the salt, placed in a porcelain crucible, was treated with a few drops of concentrated sulphuric acid and heated gently. After ignition with a Bunsen flame the zinc was weighed as zinc oxide.

Analysis :

	Zinc Per cent.
Calculated for $C_{36}H_{62}Br_8O_4Zn$	5.17
Found	5.31

Calcium salt of alpha linolic tetrabromide.—Eight grams of alpha linolic tetrabromide were dissolved in 200 cubic centimeters of hot ethyl alcohol (95 per cent.) and to this hot solution 27.5 cubic centimeters of alcoholic potassium hydroxide solution (1 cubic centimeter = 0.02873 gram potassium hydroxide) containing a very slight excess of the calculated amount of potassium hydroxide were added with vigorous shaking. The mixture was heated (reflux) on a water bath for about two hours. The solution of the potassium salt was then treated with an alcoholic solution of calcium bromide (1.5 grams $CaBr_2$ dissolved in 125 cubic centimeters of ethyl alcohol) containing a very slight excess of the calculated amount of calcium bromide. The calcium salt of alpha linolic tetrabromide was precipitated. When the mixture was boiled (reflux) on a water bath the liquid above the precipitate became perfectly clear. The boiling was continued for about four hours to insure the completion of the reaction. The mixture was then cooled and the calcium salt removed by filtering, after which it was washed with ethyl alcohol (50 per cent.) until the washing gave a negative test with silver nitrate which indicated that no potassium or calcium bromides were present as impurities. The calcium salt was then washed with hot ethyl alcohol (95 per cent.) to remove any unchauged alpha linolic tetrabromide. The salt was then dried in a vacuum desiccator.

When the melting point was determined, the salt began to turn brown at 208.7° C. and melted completely at 213.4° C. with decomposition.

In order to check the formula a weighed quantity of the salt was treated with sulphuric acid and the calcium determined as calcium sulphate.

Analysis :

	Calcium Per cent.
Calculated for $C_{36}H_{62}Br_8O_4Ca$	3.24
Found	3.03

Strontium salt of alpha linolic tetrabromide.—The strontium salt of alpha linolic tetrabromide was prepared by mixing a hot solution of 8 grams of the tetrabromide dis-

solved in 200 cubic centimeters of ethyl alcohol (95 per cent) with a slight excess of half normal alcoholic potassium hydroxide. The mixture was heated (reflux) on a water bath for about three hours and then treated with a hot alcoholic solution of strontium bromide which was prepared by dissolving 2.7 grams of crystallised strontium bromide ($SrBr_2.6H_2O$) in 50 cubic centimeters of ethyl alcohol. The mixture was diluted with hot ethyl alcohol to a volume of about 1,200 cubic centimeters and heated (reflux) on a water bath until the liquid above the precipitate was perfectly clear, indicating that the reaction was complete. This required about ten hours. As a portion of the alcohol evaporated while the mixture was boiling, small quantities of alcohol were added occasionally to replace the loss.

The mixture was then cooled to room temperature and the strontium salt removed by filtering. The strontium salt was washed with ethyl alcohol (50 per cent.) until free from bromides, as determined by the silver nitrate test. The salt was next washed with hot ethyl alcohol (95 per cent.) to eliminate any unchanged tetrabromide and dried in a vacuum desiccator.

The melting point determination showed that the salt began to turn brown at 200.4° C., and melted completely at 206° C. with decomposition.

The formula was checked by treating a portion of the salt with sulphuric acid and determining the strontium as sulphate.

Analysis :

	Strontium. Per cent.
Calculated for $C_{36}H_{62}Br_8O_4Sr$	6.81
Found	6.52

Barium salt of alpha linolic tetrabromide.—Eight grams of alpha linolic tetrabromide were dissolved in about 200 cubic centimeters of ethyl alcohol. The solution was treated with a slight excess of the calculated amount of half normal alcoholic potassium hydroxide solution and heated (reflux) on a water bath for about one and a half hours. A solution of barium bromide was prepared by treating 2.36 grams of crystallised barium bromide ($BaBr_2.2H_2O$) with 5 cubic centimeters of water and 100 cubic centimeters of hot ethyl alcohol. The hot clear solution of barium bromide was added to the alcoholic solution of the potassium salt previously prepared. The mixture was diluted with about 150 cubic centimeters of ethyl alcohol and heated (reflux) on a water bath until the liquid above the precipitate was entirely clear. This required about six hours. Small quantities of ethyl alcohol were added from time to time to replace the alcohol lost by volatilisation.

The mixture was then allowed to cool and was filtered. The barium salt was then washed with ethyl alcohol (50 per cent.) until free from bromides as indicated by the silver nitrate test. The salt was next washed with hot ethyl alcohol (95 per cent.) to remove any linolic tetrabromide and dried in a vacuum desiccator.

A determination of the melting point showed that the salt began to turn brown at 196.3° C., and melted completely at 202.5° C. with decomposition.

The salt was analysed for barium by treating a portion with sulphuric acid and determining the barium as sulphate.

Analysis :

	Barium Per cent.
Calculated for $C_{36}H_{62}Br_8O_4Ba$	10.29
Found	9.87

Sodium salt of alpha linolic tetrabromide.—Twenty grams of alpha linolic tetrabromide were dissolved in 600 cubic centimeters of hot ethyl alcohol. The solution was treated with 70.5 cubic centimeters of alcoholic sodium hydroxide solution (1 cubic centimeter = 0.02943 gram sodium hydroxide). The mixture was heated (reflux) on a water bath for about three hours to eliminate the turbidity and then poured into a beaker, diluted witb about 100 cubic centimeters of ethyl alcohol, and cooled. The gelatinous sodium salt was removed by filtering and washed with ethyl alcohol. The salt was then recrystallised from hot ethyl alcohol (95 per cent.) and dried in a vacuum desiccator. The sodium salt is considerably more soluble in ethyl alcohol than are the other salts that were prepared. The filtrate and washings from the first crop were concentrated to about a fourth of the original volume and a second yield was obtained.

The melting point determination showed that the salt began to turn brown at 194.2° C., and melted completely at 201.1° C. with decomposition.

The percentage of sodium was determined by converting a portion of the salt into sodium sulphate.

Analysis :

	Sodium Per cent.
Calculated for $C_{18}H_{31}Br_4O_2Na$	3.69
Found	3.28

Melting point.—A determination of the melting point of the salts that were prepared showed that most of them decomposed when heated to a sufficiently high temperature. This is not unusual since, according to the literature, a number of salts of long-chain aliphatic acids do not give a sharp melting point.

SUMMARY.

Alpha linolic tetrabromide (melting point. 112.3 to 114.3° C.) was prepared from lumbang oil.

The sodium and potassium salts of alpha linolic tetrabromide were prepared by treating an alcoholic solution of the free acid with an alcoholic solution of the corresponding alkali.

From the potassium salt of alpha linolic tetrabromide the zinc, barium, calcium, and strontium salts were prepared.

The melting point of these compounds was determined and the formulæ were checked by analysis.

The solubility of the sodium, potassium, zinc, barium, calcium, and strontium salts of alpha linolic tetrabromide was determined for various solvents.

NEW BIOLOGICAL BUILDINGS AT BIRMINGHAM UNIVERSITY.

With the progress of the biological sciences, both methods and needs have changed. The laboratories and apparatus of a generation ago are no longer adequate even for teaching purposes, still less for research. At Birmingham the three cognate Departments of Botany, Zoology, Brewing and Biochemistry of Fermentation have long been inadequately housed in the older part of the University in Edmund Street. This session, however, they have moved to their new quarters at Edgbaston. The new Biological block was formally opened on October 20, by the Prime Minister, Mr. Stanley Baldwin.

The buildings, the site and general character of which form part of the original design of Sir Aston Webb, face University Road, being situated between the Chemical Department and the Harding Library. The total cost of buildings and equipment is upwards of £120,000, towards which Sir William Waters Butler, Bart., has generously contributed £40,000, and an anonymous donor £5,000.

Zoology occupies the ground floor of the new block, Brewing and Biochemistry of Fermentation the greater part of the first floor, and Botany the second floor, with certain rooms also on the first floor. A large lecture theatre, shared by all three departments, each of which also has its own lecture room, forms a third floor.

One important development is the recognition of the principle of departmental libraries. Each of the three departments in the new block has its own separate library, in which will be housed nearly all the periodicals and books dealing with the three subjects respectively. These departmental libraries will be under the general supervision of the University Librarian and the Library Committee.

The three departments have already started work in the new buildings, although the internal equipment and furnishing is not yet complete. The following is a description of the Zoological Department :

ZOOLOGY.

The new Zoological Department of Birmingham University, which forms the ground floor of the Biological Block, has been constructed on a spacious scale. There are three teaching laboratories, for elementary, for advanced, and for post-graduate honours students respectively. The laboratories have ample accommodation, good lighting, both daylight and artificial illumination, and modern fittings. The Department possesses a small lecture theatre for advanced teaching, while the zoologists, botanists and biochemists between them share a large theatre. This lecture theatre accommodates the large elementary class the greater proportion of whom are medical students.

The Department possesses a museum. In the case of a University Zoological Museum, which in most instances is necessarily small, there is a danger of falling between two stools. An attempt is sometimes made at providing a show museum. This attempt can rarely succeed owing to lack of room and funds. At the same time such a museum fails to be a well-equipped collection purely for teaching purposes. It is the second object which is valuable in a University Zoological Department and which can successfully be attained, whereas the show collection can never be a success except in large and rich musuem. In the new Birmingham Zoological Department the museum is solely an instructional one and for this purpose it is admirably stocked

There is a departmental library which is very well provided with Zoological treatises, original memoirs, biological periodicals and a representative collection of up-to-date books dealing with the border-line sciences. The importance of a departmental library cannot be over-estimated. On the occasion of the construction of the new Zoological Department the University of Birmingham has been very well advised in creating a departmental library; and as has been pointed out, this will be organically connected with the Central and General Library.

Original research is as much the *raison d'etre* of a University scientific department as in teaching. For the purposes of research this new Zoological Department is admirably equipped. The University has not been content with providing an elegant shell and with well designed bench fittings, etc., but a large sum of money has been expended on the purchase of apparatus. This includes not only the microscopes and microtomes of the classical Zoological laboratory, but the numerous and often elaborate apparatus used in the newer experimental developments of the science.

The members of the staff have each a private room fitted out as a laboratory. There is a research laboratory for other original investigators working in the department ,with a special room for entomologists, dark rooms, an animal room, a tank room, etc.

Zoological science, as it advances, inevitably becomes more and more physical and chemical. Protoplasm is studied as a physico-chemical system and as our knowledge progresses the older methods of research are supplemented and in part replaced by physical and chemical techniques. Natural history, comparative animal morphology, gross and microscopic anatomy, remain and always will remain the foundation stones of Zoology, but physiology, in the widest sense of the word, becomes more and more an essential viewpoint of the zoologist. In conformity with this tendency, the new Zoological Department at Birmingham is fully fitted out with the physical and chemical equipment necessary for work in comparative physiology and in experimental zoology.

The greatest variety of life exists in the sea. It is natural therefore that living marine animals should be the first requisite of a zoological laboratory both from the aspects of research and of teaching. For the study of natural history, or ecology, of comparative physiology, or of animal behaviour, it is necessary to have the means of keeping marine animals alive although the situation may be far removed from the sea. Particular attention has been paid to this requisite at Birmingham by the provision of tank-rooms containing acquaria with arrangements for filtering, circulating, and aerating the sea-water. Nor is the fresh-water fauna neglected. Birmingham is well-known to be situated in a region where the fauna of ponds and streams is particularly rich and varied. This has been borne in mind in equipping the new department.

For a series of years Birmingham University has turned out good research work in entomology. One member of the staff of the Zoological Department is always an entomologist. This is of great importance since entomology is one of the principal branches of applied zoology. The new department is particularly well equipped for entomological teaching and research. There is a special room for this work in the building itself, an outdoor laboratory for insect breeding work, and students have access to a large fruit farm in Worcestershire for a part of the field training in the agricultural aspect of the subject.

The Department has a distinguished past record. Professor T. W. Bridge, F.R.S., one of the original professors at Mason College, Birmingham, carried out much valuable research work on fishes. His successor, the late Professor F. W. Gamble, F.R.S., is known to zoologists all over the world for his researches on the colour changes in crustaceans and for his study of the remarkable composite organism Convoluta, a plantarian worm with symbiotic algoa. The late Professor Leonard Doncaster, F.R.S., was a member of the staff when he did his epoch-making work on sex-inheritance in the moth Abraxas grossulariata. Mr. H. G. Newth the present senior lecturer is an embryologist who has made a number of important original investigations. Incidentally, a large share in the design of the laboratories and fittings falls to his credit. The present head of the Department is Professor H. Munro Fox.

In conclusion it should be pointed out that a number of different carreers are now open to University graduates who have studied zoology. Those who come at the top of the examination lists can obtain grants to assist them to train in research methods. If successful in their probationary research period they may obtain University

staff appointments. Outside an academic carreer the most numerous openings are in entomology agricultural and teaching appointments offer themselves in numbers which increase yearly as more and more schools include biology in their curriculum. A lesser number of posts are available in the Fisheries, Museums, etc.

Next week we shall describe the "Bio-Chemistry of Fermentation and the Botanical Depts."

GEOLOGICAL SURVEY, CANADA.

In this connection, it may be of interest to note that the Geological Survey Branch of the Department of Mines of Canada has already set on foot the publication of a set of reports designated the Economic Geology Series. The first of these was the one by Dr. G. A. Young, entitled "Geology and Economic Minerals of Canada," the second was the one by Dr. M. E. Wilson, entitled, "The Talc Deposits of Canada," the third was by Drs. G. A. Young and W. G. Uglow entitled "The Iron Ores of Canada," and the fourth by Dr. M. E. Hurst on the Arsenic-Bearing Minerals of Canada."

THE FERTILISER INDUSTRY.

Address Prepared by The Right Hon. Sir Alfred Mond, Bt., M.P. (Chairman, Imperial Chemical Industries, Ltd.), for The Imperial Agricultural Research Conference, Billingham, Tuesday 18 October, 1927.

(Continued from Last Week.)

"I have often stated that Britain has become over-industrialised. She has lost the balance between agriculture and industry. Many of the most complex of our social and economical problems have arisen from this fact. I feel that the fertiliser industry will help to restore the balance between industry and agriculture to equity.

There is at this moment a world tendency towards the formation of large groups. Whole industries are amalgamated, as my lac kof leisure tells me to my cost. Various groups of nations are becoming more closely connected, both politically and industrially, and not the least of these is the British Empire, which economic forces and improved means of commnnication are rapidly welding into a homogenous whole. If we do not hang together, we shall hang separately.

Even in industrial England, agriculture is our greatest trade, and it is unnecessary to tell you of its importance in the Empire. The extended use of fertilisers such as we are now beginning will play a large part in encouraging agriculture and thereby assist in increasing the prosperity and cohesion of the Empire.

I would remind you, however, that vast as is the organisation you will see to-morrow, it can only produce a fraction of the output already available elsewhere. Inasmuch as the world continues year by year to be capable of absorbing the vast and ever increasing output of synthetic nitrogenous fertilisers, it is evident that we will not remain content to produce a quantity which though large in itself is small in comparison with the world's output and the requirements of the Empire. We will not be content with merely participating on the basis of our present production. Additional units are to be erected immediately. We shall endeavour to keep pace with the increased Imperial and world demand.

Foreseeing the possibility of these great developments we recognise that a selling organisation must be formed on such a scale that it would be capable of handling not only existing supplies of fertilisers, but also the potentially vastly greater quantities, which we confidently expect to make. In doing this, we have made use of existing organisations, and have developed them. The consequence of this has been the formation of Nitram, which combines all the previous existing selling organisations with the additional help which we have been able to give.

But a selling organisation, however efficient, cannot do all the work that is required, if the synthetic fertiliser industry of this country is to be developed and hold its own in the world. It is no exaggeration of language to say that, with the large scale manufacture of synthetic nitrogenous fertilisers, a new era has dawned on the world. It is the era of nitrogen plenty. Before the coming of synthetic nitrogenous fertilisers, the sum total of life upon this planet was limited by the amount of available nitrogen. The only synthetic agents for augmenting supplies of nitrogen compounds suitable for supporting vegetable life were the vetches and the clovers on the one hand, and on the other the nitrogen-fixing bacteria of the sea and of the soil. The slow rate of action of these agents set a limit to the development of plants, animals, and of human societies. With the advent of synthetic

nitrogenous fertilisers this limit has been removed. Nature can no longer parsimoniously say to life 'Thus far shalt thou go and no farther.'

New knowledge and new sources of power must, however, be made known before they are widely used, and therefore Nitram Limited determined that, side by side with the large selling organisation which it had formed, there must be a no less large and world wide propagandist organisation whose business it should be to make known the uses and values of the new synthetic fertilisers. The admirable service instituted by the British Sulphate of Ammonia Federation formed the nucleus of this advisory service of Nitram Limited. This service is rapidly growing; already it has a large staff of district advisers located in all parts of England, Scotland and Ireland whose sole duty it is to give free and disinterested advice to farmers on the use of fertilisers—not only nitrogenous fertilisers, but fertilisers of all kinds.

Nitram Limited has also established a research station, wth upwards of 400 acres of farm lands, where problems relating to the use of fertilisers and to the feeding of stock are to be investigated. One of the most important subjects which will be undertaken at the Research Station is the experimental enquiry as to the synthetic fertilisers most suitable to the British and Overseas requirements, for it is evident that the synthetic manufacturing activities of Billingham are not likely to be confined to the manufacture of simple nitrogenous fertilisers, such as sulphate of ammonia, but will extend to the production of what may be called dual and triple fertilisers. Some soils require mainly one ingredient, say nitrogen; some soils require both nitrogen and phosphates, or nitrogen and potash and all intensively cultivated soils require frequent applications of nitrogenous, potassic and phosphatic fertilisers. Therefore, the producers of the synthetic fertilisers of the future will be engaged in the manufacture of what may be called simple, dual, and triple fertilisers. There will be sulphate of ammonia or synthetic nitrate or urea, etc., to supply the nitrogen requirements of the soil; there will be ammonium phosphate for the soils which need both nitrogen and phosphates; and there will be complete chemical compound fertilisers, containing the three chief plant foods, to be used by all who cultivate the land intensively. Nitrogen, Phosphates and Potash form the Trinity.

There seems to be a misapprehension about the nature of fertilisers. Chemical compounds are chemical compounds whether produced by man or nature. The idea that there is any mysterious difference between a synthetic and the natural product, is based upon inaccurate thinking and not upon reason. For example, Natural and artificial Indigo are indistinguishable from each other.

It is certain that great prosperity will come to those countries which are first to seize and apply the new and great opportunities which present themselves now that the synthetic manufacture of fertilisers is an established fact. Nitram Limited, therefore feels that it has not only a commercial duty to fulfil, but also a national duty. It is for this reason that the energies of its staff are being directed especially to the agriculture of England, Scotland and Ireland. It is clear that with these new resources at its service, British agriculture is furnished with the powerful means of reinforcement in the struggle which it has been waging for years with manifold adversities. All must hope that plentiful supplies of synthetic fertilisers will help agriculture to maintain the struggle so that when world conditions become more favourable, prosperity may once again smile on the most essential of all British industries.

In conclusion, may I say that mankind is at the cross roads. To those who have vision and the opportunity of applying that vision to national and imperial problems—the opportunity awaits and it must be seized. Science applied with vision can increase the natural wealth of the world and can inaugurate that reign of peace and prosperity without which our present civilisation will go backwards instead of forward."

GENERAL NOTES.

CANADIAN IRON AND STEEL.

According to final returns prepared by the Dominion Bureau of Statistics at Ottawa, and communicated by the High Commissioner for Canada in London, the value of the production of iron and steel in Canada last year reached 41,888,565 dollars, or an increase of 22 per cent. over the output value of 32,909,463 dollars reported for 1925.

CANADA'S RANK AMONG MINERAL-PRODUCING NATIONS.

The remarkable increase in its mineral production during the last twenty-five years has carried the Dominion from a place of comparative obscurity to the front rank of the mineral producing countries of the world. Canada now supplies 90 per cent. of the world's nickel, 85 per cent. of its asbestos, 55 per cent of its cobalt, 9 per cent. of its gold, nearly 9 per cent. of its silver and lead, 6.4 per cent. of its zinc, and 4 per cent. of its copper. In world production the Dominion is first in nickel, cobalt and asbestos, third in gold and lead, fourth in silver and fifth in copper. The Canadian record of production over so wide a range of important minerals has seldom, if ever, been surpassed, and it may be noted that thatistics show the Canadian production of minerals, both in quantity and variety, to be still increasing steadily.

GERMAN TRADE—ALL-ROUND IMPROVEMENT.

The period May, 1926, to June, 1927, was one of uninterrupted improvement in every branch of German trade and industry, write Messrs. J. W. F. Thelwall, M.C., and C. J. Kavanagh, British Commercial Secretaries at Berlin, in their Report on Economic and Financial Conditions in Germany. This was due partly to the natural process of recuperation which set in after the stabilisation of currency and partly, at any rate in its beginnings, to the labour troubles in Great Britain.

The acute shortage of credit and working capital which had such a paralysing effect from the middle of 1925 to early in 1926 completely disappeared, and was replaced by a much easier money market. Of course, foreign loans continued to play an important part in meeting the requirements of German industry, but the creation of internal capital also made fair progress; it is estimated that it has been at the rate of about 6,000 million marks (£300,000,000) per annum since stabilisation.

Taxation. British and German Much the Same.

Important as the question of taxation is in considering competitive power, it is impossible to make any just comparison without a searching scientific examination of the wealth and the tax burdens of the two countries—a task of such magnitude and difficulty that it is never likely to be undertaken. In the absence of reliable figures the isolated statements which appear from time to time showing the tax yield per head of the population, the present taxes paid by an individual or firm compared with those paid before the war, the tax burden resting upon a ton of coal or steel, etc., are useless for purposes of comparison. The writers of the Report state, as a purely personal opinion, that, taking the taxes levied by the Reich, the States, the municipalities and districts, together with the social charges, into account, the total burden is probably very much the same in the two countries.

PHYSICS IN THE FOOD INDUSTRY.

The Institute of Physics announces the Thirteenth lectures of its series "Physics in Industry," which is to be given at 5.30 p.m., on Monday, November 14, 1927, in the rooms of the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. The lecturer on this occasion is Sir William Hardy, M.A., F.R.S., Director of Food Investigation at the Department of Scientific and Industrial Research, and his subject, "Physics in the Food Industry."

The application of physical methods to the conservation of food resources is a subject of national importance, and the lecture should be of considerable interest to a far wider public than the membership of the Institute of Physics. The Board of the Institute wishes it to be known that it is open to the public, without charge. Admission is by ticket, and tickets may be obtained on application to the Secretary, The Institute of Physics, 1, Lowther Gardens, Exhibition Road, London, S.W.7.

The chair will be taken by the President of the Institute, Sir Frank Dyson, K.B.E., F.R.S.

CANADIAN MINING A RIVAL TO AGRICULTURE.

In the past, the industrial development of Canada has been mainly confined to the expansion of its agricultural activities and many people who are not familiar with recent Canadian progress still regard the future of the Dominion as being almost exclusively dependent upon its agricultural resources. However, important progress has been made in other fields of industrial activity, some of which have already attained a standing unthought of at the close of the nineteenth century; and of these mining and its allied industries easily take

first place. It has been suggested, in fact, that ten or fifteen years hence the annual mineral production of the Dominion may loom up as large in a financial way, as her wheat crop.

GOLD COAST TRADE EXPANSION.

The Gold Coast Government Commercial Intelligence Bureau in London reports that the Customs receipts of the Gold Coast Colony in September amounted to £282,027, an increase of £93,804 over those for September, 1926. Total receipts from 1st April to 30th September were £1,160,291, or £365,040 more than for the correspond ing period of last year.

Imports into the Colony for the nine months January-September the value was £7,452,093, as against £5,478,991 in the corresponding period of 1926, showing an increase of £1,973,102.

Exports from the Colony.—The total value for January-September, 1927, was £9,599,174, as against £7,044,009 in the first nine months of 1926, or a rise of £2,555,165.

The total increase in the value of the Colony's trade in January-September, 1927, as compared with the corresponding period of 1926, was £4,528,267.

HOT VERSUS COLD AIR IN BLAST FURNACES.

An esteemed correspondent points out that for some unknown reason, pig iron made with cold air in the blast furnace undoubtedly gives a higher quality product that that made in the ordinary way at present with a hot blast. There seems to be no question about this at all, and of course the reason why we do not operate blast furnaces in general with cold air is because of the cost, that is the loss in heat. The point is, howeveer, that for many operations such as colliery and iron and steel work, chemical plant, railway work, and engineering in general, to take four cases only, it is claimed to be a paying proposition to use this cold blast iron although it costs more than ordinary iron. The whole question of blast furnace operation becomes more complicated and mysterious as we go along, and in the same way for example there is no question that the old charcoal iron is superior to any product made with coke, but we cannot of course make charcoal iron on a large scale to-day because there is hardly any wood available.

Proceedings and Notices of Societies.

INSTITUTE OF CHEMISTRY.

30, Russell Square, London.

The annual meeting of the London and South Eastern Counties Section will be held at 8 p.m. on Wednesday, November 16, Prof. J. C. Drummond presiding. After the election of officers and the transaction of other routine business, a smoking concert will follow, which will commence between 8.15 p.m. and 8.30 p.m. The Secretary appeals to members who are willing to contribute to the programme to notify him as soon as possible. Offers of assistance will be greatly appreciated.

As the Jubilee Celebrations will be held from 14 to 16 December, the Committee have decided not to hold a Section Meeting in December. They request, however, that all members will bear in mind the importance of the Jubilee Celebrations of the Institute.

MINERALOGICAL SOCIETY.

The annual general meeting of the Mineralogical Society was held on November 1, and the following officers und members of council were elected :— *President*, Dr. G. T. Prior; *Vice-Presidents*, Sir J. S. Flett, Sir T. H. Holland; *Treasurer*, Mr. F. N. Ashcroft; *General Secretary*, Mr. W. Campbell Smith (Natural History Museum, S. Kensington, S.W.7); *Foreign Secretary*, Dr. J. W. Evans; *Editor*, Dr. L. J. Spencer; *Ordinary Members of Council*, Prof. P. G. H. Boswell, Prof. H. L. Bowman, Mr. A. J. Bull, Mr. T. Crook, Prof. C. G. Cullis, Prof. W. T. Gordon, Dr. H. F. Harwood, Mr. L. Hawkes, Prof. H. Hilton, Dr. W. F. P. McLintock, Dr. G. F. Herbert Smith, Dr. H. H. Thomas.

The following papers were read at the meeting, Dr. G. T. Prior, F.R.S., President, in the chair :—

Specific Gravities of Minerals : An Index of Some Recent Determinations. By Dr. L. J. Spencer.

Specific gravity as determined by heavy liquids affords a convenient first-aid in the determination of minerals. 2227 determined values collected from the recent mineralogical literature are arranged numerically, and an alphabetical index of mineral names gives the minimum and maximum values for each mineral.

South African Occurrences of Willemite. Fluorescence of Willemite and some other Zinc Minerals in Ultra-Violet Rays. By DR. L. J. SPENCER.

Willemite is described from Brokern Hill and two other localities in Northern Rhodesia, where it appears to be of abundant occurrence, and from Guchab in South-West Africa. Unlike the willemite of Franklin Furnace, New Jersey, some of these do not fluoresce in ultra-violet light. Fluorescence is not a constant and essential character of a mineral species, and it evidently depends on the presence of admixed impurities.

A Study of Bauxite. By DR. T .V. M. RAO.

Specimens of laterite from India, Gold Coast, and other countries were described. It was shown that laterite was a rock largely composed of the mineral bauxite, which had a definite composition corresponding to the formula $Al_2O_3,2H_2O$. Details of an experiment to trace the process of laterisation in nature were also given.

On the Biotite-bearing Greenstones and on a Rhyolitic Pumice in the Metamorphic Aureole of the Falmouth Granite. By DR. P. K. GHOSH.

The biotite constituent, which has so far been ascribed to the metamorphic action of the Armorican granite on the pre-existing greenstone, is proved to be the undigested and residual part of the slate fragments stoped by the " greenstone " magma at the time of its intrusion. Rhyolitic pumice is noted for the first time in this region and its mineralogical characters are described.

THE CHEMICAL SOCIETY.

Papers read, Thursday, November 3 :—

The Complex Salts of Nickel with various Aliphatic Diamines. By F. G. MANN.

Attempts have been made to obtain more decisive evidence for the configuration of the tetrammino-nickelous complex by co-ordinating nickel with diamines.

If the nickel complex has the uniplanar configuration, all these salts should exhibit *cis-trans* isomerism; if the complex has the tetrahedral configuration, they should be resolvable into optically active forms. Actually, although all the above salts were highly crystalline compounds, no trace of *cis-trans* isomerism could be detected, whilst all attempts to resolve the first, fourth, and fifth salts failed.

Although bivalent nickel can show a co-ordination number of 6 as well as 4, the metal could not be co-ordinated with three molecules of any of the diamines used, a result in favour of the uniplanar configuration for the 4-co-ordination complex.

The Mechanism of the Formation of Citric and Oxalic Acids from Sugars by Aspergillus Niger. By T. K. WALKER, V. SUBRAMANIAM AND F. CHALLENGER.

When the mould is grown on potassium hydrogen saccharate solution, potassium citrate is formed. The importance of saccharic acid in the mycological production of citric acid is evidenced by its isolation in the form of its potassium hydrogen salt from cultures of *A. niger* on glucose. Calcium saccharate is produced when the mould is grown on solutions of calcium glnconate. This was to be expected since gluconic acid is known to be formed when *A. niger* is grown on glucose.

The formation of acetone is cultures of *A. niger* on citric acid was ascribed to the decarboxylation of acetonedicarboxylic acid, although proof of the presence of this acid was lacking; it has now been detected in ammonium citrate cultures.

Oxalic acid is prodnced by growth of the mould on ammonium acetonedicarboxylate. Acetic acid may readily be obtained from *A. niger* cultures on citric acid.

The Complex Cyanides of Molybdenum. By W. R. BUCKNALL AND W. WARDLAW.

Abnormally, molybdenum and tungsten in the complex cyanides $K_4Mo(CN)_8$ and $K_4W(CN)_8$ are converted by acid permanganate to the quinquevalent state only. The oxidation from the quadrivalent to the quinquevalent condition is now clearly shown by the isolation of the complex salts $R_3Mo(CN)_8$ from the fully oxidised solution of $K_4Mo(CN)_8$. The complex acid $H^3Mo(CN)_8$, $3H_2O$ has also been prepared. From a consideration of the electronic theory of valency an explanation of this abnormal oxidation with acid permanganate is put forward. New salts $[Cu(NH_3)_3]Mo(CN)_8$, $[Cu(en)_2]_2Mo(CN)_8$ in which the copper exhibits co-ordination numbers of 3 and 4 have been prepared and a study of the so-called red and blue cyanides of quadrivalent molybdenum has been made.

The action of concentrated nitric acid on $K_4Mo(CN)_8$ can be made to yield a complex acid $H[MoO_2(CN)_2, 2H_2O$ in which molybdenum is quinquevalent. Further oxidation with acid destroys the complex salt.

The Parachor and Chemical Constitution. Some Cases of Supposed Ring-Chain Tautomerism. By F. B. GARNER AND S. SUGDEN.

The parachor, because of its strictly additive character, is unable to distinguish between tautomerides which differ only by the position of a double linking in the molecule. If, however, isomeric change causes the production of a ring instead of a double linking, the isomerides should possess different values for this constant.

The values of the parachors of quinone, toluquinone, succinyl chloride, the two forms of phthalyl chloride, benzil, and 2 : 2'-dimethoxybenzil indicate that these substances, with the exception of the higher melting isomeride of phthalyl chloride, all possess the normal structure and, in the liquid state, cannot contain more than a small amount of the isomeride in which a new ring is produced by isomeric change.

The parachors of the phthalyl chlorides indicate that the form m.p. 15° has the symmetrical structure, whilst the isomeride m.p. 88.5° has the unsymmetrical formula.

The Colouring matters of Carajura. By E. CHAPMAN, A. G. PERKIN, AND R. ROBINSON.

Carajura is a rare red pigment prepared from the *Bignonia chica* by the Indians of the Rio Meta and the Orinoco for use as a flesh-paint. The specimen examined was found to contain peaty matter, wax, a coloured resin, silica, calcium oxalate, and other salts of calcium, magnesium, and potassium, and colouring matters, of which two have been isolated. The more important of these, *carajurin*, has the composition $C_{17}H_{14}O_5$ and is the anhydro-base corresponding with a dihydroxydimethoxyflavylium salt. On boiling with hydriodic acid, it yields *carajuretin hydriodide*, $C_{15}H_{10}O_5$, HI and from this *carajutin*, $C_{15}H_{10}O_5$, may be obtained in scarlet needles. *Carajuretin hydrochloride*, is identified with the synthetically prepared *scutellareinidin chloride*, and therefore 5 : 6 : 7 : 4'-tetrahydroxyflavylium chloride.

Carajurone, a second colouring matter of carajura, appears to be a *carajuretin monomethyl ether*. The action of bromine on carajurin in acetic acid solution gives a *dibromocarajurin dibromide*, $C_{17}H_{12}O_5Br_4$, which is decomposed by acetone forming *dibromocarajurin*. Acetyl derivatives of the hydrated forms of carajurin and carajuretin have been prepared and O-*pentaacetyldihydrocarajuretinol* is of particular interest.

Certain derivatives of 1 : 2 : 3 : 5-tetrahydroxybenzene are described, advantage having been taken of the opportunity to explore the ground for the syntheses of quercetagetin and gossypetin. Thus iretol monomethyl ether is shown to be 2 : 5-dimethoxyresorcinol has been synthesised from veratrole. The method for the preparation of antiarol has been improved and *antiarolaldehyde* $(MeO)_3C_6H(OH).CHO$, obtained from it by the Gattermann synthesis. Condensation of antiarolaldehyde and *p*-acetylanisole in presence of hydrogen chloride gave 5 : 6 : 7 : 4'-*tetramethoxyflavylium chloride*, and from this scutellareinidin chloride was obtained by demethylation. A number of other flavylium salts, related to this series, have been prepared.

THE CHEMICAL SOCIETY.

Professor W. A. Bone, D.Sc., F.R.S., will deliver a lecture entitled "Gaseous Combustion at High Pressures," in the rooms of the Chemical Society, Burlington House, London, W.1., on Thursday, November 24, 1927, at 8 p.m.

SOCIETY OF GLASS TECHNOLOGY.

The opening meeting of the Society of Glass Technology for the Session 1927-28 was held in Sheffield on Wednesday, October 19th, the President, Mr. Walter Butterworth, Senr., M.A., in the chair.

Following an introductory address by the President, two papers were presented.

Opal Glass. Crystal Growth and Impact Brittleness. By J. F. HYSLOP, B.Sc. (A communication from the Research Laboratories of the General Electric Co., Ltd.)

It was shown that the fluoride particles in an opal glass were globular if the viscosity of the glass was high. With low viscosity the particles assumed characteristic crystalline form. In an opal glass heated under the critical point found by Gohlhoff and Thomas, the logarithm of the particle size was directly proportional to the reciprocal of the absolute temperature. That is, the particle size, for equal times of heating under the critical point, was inversely proportional to the viscosity of the glass. Impact brittleness in opal glass was associated

with several factors. The chief cause of brittleness was the tendency of the glass to produce sharp angular crystals and those might be formed by : (*a*) the tendency of the matrix to precipitate silica. If the opal was susceptible to this secondary devitrification, a careful choice of working temperature was necessary, if the absence of brittleness was desired ; (*b*) the tendency of the glass to grow angular instead of globular fluoride particles. This happened in a glass of low viscosity and such a glass was brittle at low and high working temperatures.

Impact brittleness had in one instance been associated with heterogeneous glass and in this connection it was shown that the size of cullet was an important factor in the production of a homogeneous glass.

The Detection of Selenium in Decolourised Bottle Glass. By R. J. C. BOWMAKER, B.Sc., AND J. D. GATWOOD, M.Sc.

The procedure consisted in treating 2 to 3 grams of glass in platinum with 15 to 20 cc. of hydrofluoric acid and 2 cc. of strong nitrict acid, and evaporating to dryness at about 90° C. To the residue, 4 to 5 cc. of strong nitric acid were added and the solution again evaporated to dryness. The residue was then dissolved with 5 cc. of 1 : 1 nitric acid and a little water added to the solution. 10 cc. of strong sulphuric acid were added, and the whole evaporated until fuming for a few minutes. The solution was allowed to become quite cold, when a piece of codeine sulphate, about the size of a pin's head, was added and stirred until dissolved. The solution was then heated to the fuming point when a green coloration denoted the presence of selenium. Manganese and copper must be absent.

The third paper on the agent was taken as read, namely, " The Birmingham Glass Trade, 1740 to 1833." By Francis Buckley.

FORTHCOMING EVENTS.

ROYAL SOCIETY OF ARTS.

John Street, Adelphi, London.

Monday, November 14, at 8 p.m.—(Cantor Lecture). Professor Henry C. H. Carpenter, M.A., Ph.D., F.R.S. : " Alloy Steels, their Manufacture, Properties and Uses." (Lecture I.)

Wednesday, November 16, at 8 p.m.—(Ordinary Meeting.) Professor Leonard Hill, M.B., F.R.S., Hon. A.R.I.B.A. : " Overcrowding in Public Conveyances."

The Right Hon. Lord Dawson of Penn G.C.V.O., K.C.B., K.C.M.G., M.D., D.C.L. will preside.

UNIVERSITY COLLEGE.

Gower Street, London, W.C.1.

Tuesday(November 15, at 5.30 p.m.—" L'œuvre Dramatique de Maeterlinck." A public lecture in French by M. Emil Cammaerts.

Wednesday, November 16, at 5.30 p.m.—" The Decoration of Bookbindings." A public lecture by Mr. P. B. James. (Lantern illustrations.)

Thursday, November 17, at 5.30 p.m.—"Di alcuni Poeti scienziati dell' Ottocento." A public lecture in Italian by Dr. A. M Bassani.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, London, W.C.2.

Thursday, November 17, at 6 p.m.—Mr. B. S. Cohen : " Apparatus Standard of Telephonic Transmission, and the Technique of Testing Microphones and Receivers."

NORTH-EASTERN CENTRE,
at Armstrong College, Newcastle-on-Tyne

Monday, November 14, at 8 p.m.—Mr A. H. Low, and Mr. J. P. Chittenden " Higher Steam Pressures and their Application to Steam Turbines."

NORTH-WESTERN CENTRE,
at the Milton Town Hall, Manchester.

Tuesday, November 15, at 7 p.m.—W McClelland, C.B., O.B.E. : " The Application of Electricity to Warships."

THE ROYAL INSTITUTE OF PUBLIC HEALTH.

37, Russell Square, W.C.1.

Wednesday, November 16, at 4 p.m.—" The Milk Supply—What Shall our Policy Be? " By R. Stenhouse Williams, M.B. D.Sc., D.P.H.

GEOLOGICAL SOCIETY.

Burlington House, London, W.1.

Wednesday, November 16, at 5.30 p.m.—" The Belemnite-Marls of Charmouth : a Series in the Lias of the Dorset Coast." By William Dickson Lang, M.A., Sc.D., F.G.S. Leonard Frank Spath, D.Sc., F.G.S., Leslie Reginald Cox, M.A., F.G.S., and Helen Marguerite Muir-Wood, M.Sc., F.G.S.

ROYAL INSTITUTION.

21, Albemarle Street, W.1.

Tuesday, November 15, at 5.15 p.m.—"Light and Sight." By Sir J. H. Parsons.

Tuesday, November 15, at 9.15 p.m.—"Les Conceptions Modernes de la Matiere et de la Science Classique." By M. Paul Painleve.

Thursday, November 17, at 5.15 p.m.—"London Before the Norman Conquest." By Dr. R. E. M. Wheeler.

Saturday, November 19, at 3 p.m.—"Samuel Wesley and Robert Pearsall." By Gustav Holst. (*With musical illustrations.*)

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Tuesday, November 15, at 4.30 p.m.—*Council Meeting.*

INSTITUTE OF METALS.

SCOTTISH LOCAL SECTION,
at 39, Elimbank, Glasgow.

Monday, November 14, at 7.30 p.m.—"Brass Foundry Practice." By A. Logan.

INSTITUTE OF CHEMISTRY.

30, Russell Square, London.
Wednesday, November 8.

CHEMICAL SOCIETY.

Burlington House, London, W.1.
Thursday, November 17.

CHEMICAL ENGINEERING GROUP.

Friday, November 18.

NOTICES OF BOOKS.

Aanlytical Tables. By A. O. BENTLEY, Ph.C., AND J. G. DRIVER, M.Sc. (Lond.), A.I.C. Pp. 16. Price 6d. Oxford University Press, Technical Department. Mr. Humphrey Milford, Falcon Square, London, E.C.

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U.S.A. BUREAU OF STANDARDS.

SCIENTIFIC PAPERS.

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New Patents.

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Latest Patent Applications.

27,496.—André, E. A.—Treatment of oil seeds, etc. October 17th.

27,551.—Bomke, H.—Method of preparing hydrogen. October 17th.

28,158.—Carbide and Carbon Chemicals Corporation.—Recovery of absorbable substances. October 22nd.

27,543.—Imperial Chemical Industries, Ltd.—Compounds of aromatic diamines. October 17th.

Specifications Published.

275,158.—Suida, Dr. H.—Process for the recovery of concentrated acetic acid and other products originating in the carbonising of wood.

268,385.—Cerini, Dr. L.—Apparatus for the purification of impure solutions of caustic soda and the like on osmotic principles.

268,779.—Lichtenberger, T., and Kaiser, Dr. L.—Process for manufacturing pure white and finely distributed sulphate of barium and sulphate of calcium.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

Abstract Published.

276,393.—Treating ammoniacal liquors.—Shadbolt, S. M., and Chemical Engineering and Wilton's Patent Furnace Co., Ltd., 76, Victoria Street, Westminster.

The distillation of gas liquor and like ammoniacal liquors is performed in the presence of solvent oils, whereby the recovery from the liquor of by-products such as pyridine, phenols, and oils is facilitated; suitable solvent oils are benzine, benzene, paraffin, naphtha, and creosote. Such oils may be added to the liquor at any convenient stage prior to distillation or in the still, and further additions of oils may be made to the saturator in which the ammoniacal vapours are absorbed and to the vapours leaving the saturator. The oils and the extracted by-products ,after separation from the condensate, are separated from one another by fractional distillation or otherwise.

FORTIOR.

482,836.—Chemical substances prepared for use in medicine and pharmacy.—H. R. Napp, Ltd., 3 and 4, Clements Inn, Kingsway, London, W.C.2. October 26th.

WYMOLINE.

483,009.—Chemical substances prepared for use in medicine and pharmacy.—H. R. Napp, Ltd., 3 and 4, Clement's Inn, Kingsway, London, W.C.2. October 26th.

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THE USE OF π IN ATOMIC OPTICS.

By F. H. LORING.

In the investigations of a displacement constant discussed in these columns, as a final development an attempt was made to correlate certain atomic constants by using the displacement value, Δ_x, as a sort of basic factor, since it seemed to follow as such from numerical regularities.

The agreements were sufficiently convincing and sufficiently extensive to enable some assumptions to be implied with good reason, but the one arising out of necessity, involving a higher Rydberg constant (109889.72) than atomic optics permits, was a serious fault; yet there seemed to be no way out of the difficulty.

The fault may lie with the use of π in certain equations. It will be remembered that π is defined as follows :—*The area of a circle to a radius of 1; or the surface of a sphere to a diameter of 1; or the circumference of a circle to a diameter of 1*, or, otherwise expressed, the diameter of any true circle into its circumference. Incidentally, π can be closely calculated—to the 6th place of decimals, which is as far as is generally required in common practice—by the equation : $\pi = 3 + (8/56\frac{1}{2})$.

In the case of atomic optics, when the trueness of the circle, sphere, or ellipse, involved, is in some doubt, the question arises : *can π be taken at its true value?*

It will be seen that by substituting a slightly less value for this constant — 3.1391115, designated π, the high value for R_{ob}, as above, reduces directly to the proper value : 109737.2. In calculating Δ_H it *comes out at 0.3650.* . See *Chemical News*, Sept. 16, 1927.

It will be remembered that Jeans, in his report on the quantum theory, 1st edition, page 80, or 2nd edition, page 78, said : "The quantity h, or $h/2\pi$, is also of the same physical dimensions as angular momentum, so that if we could imagine a state of things in which angular momentum were atomic we might be in the right state of mind for attempting a physical explanation of the quantum theory. It is to be noticed that Bohr's theory implies that the angular momentum in an atom with only one electron is always a multiple of $h/2\pi$, and the brilliant agreement of this part of his theory with experiment may indicate that in these cases the angular momentum of the single electron certainly behaves as though it were atomic, but this does not carry us any perceptible distance towards a physical explanation why the atomicity exists. The quantity hc, or $(h/2\pi)c$, is of the physical dimensions of the square of an electric charge. In point of fact, $(h/2\pi)c$, if not exactly equal, is almost equal, to $(4\pi e)^2$, *i.e.*, to the square of the strength of a tube of force binding two electrons (positive and negative electrons). This suggests that the atomicity of h may be associated with the atomicity of e. The atomicity of e will not lead to the quantum theory, otherwise the quantum theory would have been fully developed long ago ; but there is, perhaps, a hope that the two atomicities may be special aspects of some principle more general than either of them. . . An attempt to give a physical explanation of the quantum theory might be based on the atomicity and possible discrete existence of tubes of force of strength $4\pi e$, ideas with which we have been made familiar in the writings of Sir J. J.

Thomson." Dr. Jeans in his little book "Atomicity and Quanta," 1926, page 47, again touches upon the same problem, writing the approximate equation $hc/2\pi = K(4\pi e)^2$, where K is a constant which is not greatly different from unity.

An attempt by the writer to obtain some sort of agreement in the above relations has led to the following equations in which the values for e, h, etc., as given in the *Chemical News*, July 8, aud Sept. 16, 1927, are used.

$e/m = (c\pi - c\pi_s)/\kappa_1$.
$\kappa_1 = 3.7$.
$(hc)/(2\pi) = (\kappa_2\pi e)^2$.
$\kappa_2 = 3.725$, should be 4 (?); or,
$(hc)/(2\pi) = K(\kappa_1\pi e)^2$,
$K = 1.01379$; or, again
$(hc)/(2\pi) = \sqrt{(3/4)}.(4\pi e)^2$ (very nearly).

It is to be noted that 3.7 as a divisor gives e/m in the first equation above. The reciprocal of 3.7 gives one of Euler's numbers :

$$E_6 = 0.2702765 \times 10^7,$$

neglecting the 10^7 multiplier. Using Euler's fractional part, just given, and working back, gives 1.7673428×10^7. In the latter case κ_1 is 3.699911. The equation may be written thus :—

$$e/m = (\pi - \pi_s.c)/(10^7/E_6) = 1.7673428 \times 10^7.$$

The value thus obtained agrees well with the present writer's calculated value 1.767488×10^7, but is it a chance coincidence?

The occurrence of π in all fundamental equations of the atom, or rather in detailed analytical equations means, evidently, that a 'circular function' is involved. If c is regarded as a spreading constant (see *Chemical News*, Nov. 4, 1927, p. 296) then the coupling of π with it as above is not without some possible significance.

The whole of radiation phenomena seems to rest upon some principle of limiting states, and the differences between certain states give rise to the phenomena of emission.

The astronomical development of the atomic-structure formulæ, involving a planetary system, is further evidence in the same direction, at least in the case of hydrogen-like atoms that are ionised. The stationary states in Bohr's theory involve steps which can be illustrated by a model as follows ;

Consider the positive field round the small nucleus of each atom made up of radial lines of force, but that these lines are not all of the same length. A spherical brush would illustrate this idea. If the bristles of such a brush are of different lengths so that there would be n bristles of one given length and n bristles of another, and so on; then, by separating out the bristles and piling them up in layers radially round a central axis, laying down the longest bristles first, those of next length next, and so on, there would be formed a pyramidal structure with circular steps. If now the electron falls into such a system (ionised), then the electron would tend to describe a cometary path round the nuclear sun (of opposite charge), but one of the steps would bind the electron into a definite step orbit.

The electron would describe, or tend to describe, a circle along the edge of a given circular step, but of course governed by its initial velocity ,etc. At any rate, it could not so well describe a path in any position in the field, much less one that is intermediate, and this is the point to be made by the model in giving a crude picture of the stationary-state conception of Bohr's theory. It might be possible to go a little further by showing that statistical mechanics, involving probability variation and a given condition, would render an account of the stepwise lengths of the lines of force.

However this may be, the electron in striking into such a system as just outlined would describe a circle along one step edge, the centrifugal force (tendency to move in a straight line) keeping it to the outer edge; but, on arriving at this edge position of stability, let it be assumed that it would oscillate so as to travel along an undulatory line the mean of which would be the circular edge of the bristles. It is not necessary here to introduce elliptical orbits which would be a further refinement. This oscillation would give rise to monochromatic radiation. With many atoms there would be many sorts of radiation which the spectroscope would resolve into step lines corresponding, according to this model, with the step-field round the nucleus of one or more types of atoms concerned.

The undulatory path of the electron is only a convention, as it is more probable that the so-called bristles would suffer a wave-motion, or tremor, when the electron settles into its stable orbit. The wave-motion would give rise to the electromag-

netic radiation which is the radiation spectroscopically analysed.

This is all conjecture, obviously, in so far as there is no experimental evidence for the idea of a step field, either atomically or otherwise.

Whatever the process may be, if the path of the electron, or a corresponding 'wave-origin' does not represent a true circle, or true ellipse, then the absolute value of π is *meaningless in the physical sense*; but, a departure from its absolute value may not be *meaningless*. Hence the Rydberg constants as formulated with π as a factor in the equation might involve π a little greater or a little less than its absolute value; or, an equivalent correction applied which comes to the same thing.

There is one feature that may be of interest in connection with the above model. If the bristles are restored to their mixed state, then, to give the electron the same characteristic behaviour, as here sketched, it would have to spread out as a thin sheath when going round or encircling the nucleus of the atom. This spreading idea agrees with the new quantum theory, and it seems also to give the idea of e as a spreading constant some measure of reality.

It must, of course, be understood that every new feature introduced shifts the difficulty of complete solution of the problem from one stage to another; generally to one more difficult of comprehension; and also that every step or stage must be experimentally proved.

AGRICULTURE AND NATIONAL EDUCATION.

By C. G. T. Morison, M.A., President of the Agriculture Section.

(Before the British Association for the Advancement of Science.)

(Continued from Page 296.)

" If it be admitted that it is desirable for each boy and girl to know something of the way in which their bread and meat are produced, something of the lives of those who produce it, and something of the sources of the food supply of their country, can the acquisition of this knowledge be justified on general educational grounds, and, if it can, is it practically possible? I assume that few would dispute the statement that the purpose of education is to enable a man to live a fuller and better life and to make a better use of his environment. Education must prepare for life and for the conditions which will be met throughout its course. Dr. Jesse Jones, in a book published last year, has endeavoured to simplify the problem of general educational policy, and to make us consider anew its fundamental purpose. As a result of his wide observations over three continents, and his experience of many different manners of education, he urges upon us to-day the importance of resisting what he terms 'Education by accretion,' and 'the need for an approach to education that is sufficiently fundamental to be accurate and sufficiently simple to be practical.' He finds the solution of his problem in what he terms the 'vital consciousness of community conditions,' and defines as one of his four fundamental educational elements 'appreciation and use of environment.'

Whether we agree entirely with Dr. Jesse Jones or not, most of us would, I think, agree to this, and most of us would further agree that the most fundamental subject that can be considered in man's environment is the satisfaction of his most urgent bodily need. The Committee of this Association which considered the question of Training for Overseas Life, while quite definitely regarding the question from the vocational angle, brought to light some very interesting opinions about the possibility of dealing with agriculture as a cultural subject in schools. In the fisrt report of the Committee presented at the Toronto Meeting occur the words : 'the undoubted value of agriculture as an educational instrument has been overlooked in the past.' In various parts of Canada the view has been deliberately taken that the study of agriculture has definitely a cultural as well as a vocational value. In nearly all the newer countries agriculture forms part of the curriculum of the secondary schools, where, however, it is regarded by many as more vocational than cultural, because of course these countries are very largely rural, and depend more directly upon agriculture for their existence. Now, although as I have indicated, the Committee was concerned with the training of boys and girls who definitely propose to go into farming overseas, these interesting opinions about the value of agriculture as an educational subject emerge. One further sentence may be cited. 'Overseas opinion . . . is much better informed and more advanced than in England, with the consequence that in the Overseas Dominions a considerable body of experience has been accumulated, which has led the way to a definite adoption of practical work on the land, wherever possible, for the urban school equally with the rural

school.' That is an indication of the lengths to which they are prepared to go in those countries where a considerable, or it may be an overwhelming, number of their pupils go into an agricultural career. The case in this country is, of course, quite different, but nevertheless I would urge that, in spite of the small number of those who take up farming as a profession at home, and in spite of the comparatively small number of those who go abroad and do so in the Dominions or elsewhere, a study of agriculture as a cultural subject is more than worth while because of the basal character of the industry, the fundamental importance of products, and the particular position of this country with respect to the food supplies of its people. The question naturally arises as to what is meant by the study of agriculture in this connection, and, while it is a question to which it is difficult to give a final answer, it is one to which a reply can best be given by considering how this subject could be developed throughout the schools and Universities. Nature study, illustrated, and taught by means of school gardens, forms an integral part of the teaching of most elementary schools, and it is a matter for regret that in many preparatory schools this teaching is not attempted. If this study be properly carried out, I think that it meets the first demand which I would make that, in the elementary stage, children should have some slight acquaintance with the plants and animals with which they are surrounded and which supply them with the necessaries of life. In the next stage, that of the public and secondary schools, formal science is a definite part of the instruction provided and of the syllabus for the school certificate and for admission subsequently to the Universities. In my opinion, much of this science is too formal, too broken up into separate subjects which appear to have little connection with each other, and no connection at all with the facts and problems of everyday life. Certain improvements have been made of late, and the inclusion of General Science as an eamination subject in the University Local Examinations and in that of the Oxford and Cambridge Joint Board are all steps in the right direction. Science for the ordinary pupil seems to me still to suffer from too much formalism, and too great a regard for, and belief in, experimental work in the laboratory. Too much practical work in the laboratory is impossible for the boy or girl to whom science is going to be a profession, but it is fatally easy to attach too much importance to the laboratory if the whole of scientific education is to be limited by what the pupil can illustrate in those laboratory experiments that he has time and ability to perform. May I refer to the Presidential Address given to the Education Setcion by Sir Richard Gregory at Hull in 1922, in which he says 'the essential mission of school science is to prepare pupils for civilised citizenship by revealing to them something of the beauty and the power of the world in which they live,' and again, 'reading or teaching for interest, or to learn how physical science is daily extending the power of man, receives little attention.' The whole tenor of his address was a plea for the expansion of scientific instruction in this humanising spirit, an end which can, I believe, best be brought about by dealing with elementary science in relation to plant and animal life, to agriculture, and the food supply of the world.

I will not weary you with details of suggestions of what I think school curricula might be. I only want at this stage to make suggestion that for the average pupil who will make little or no vocational use of his knowledge later in life, science should be approached from the plant and animal ends, that is, from the point of view of the environment of each of us, and developed into an elementary knowledge of the employment of plant and animal by man for his subsistence, of the means whereby these plants and animals are made to satisfy man's ever-increasing needs, an last, but by no means least, some slight knowledge of how this country obtains its food supply. A development of this kind would not mean the introduction of another subject into a curriculum already overcrowded, if it meant that elementary science for the normal boy consisted of this work. Naturally as the subject developed the applications of science to other industries would find their place, and would form part of a coherent whole, but the central idea would remain.

What now is the part which the Universities must play in a scheme of this sort, They should provide courses which would aim at giving their students, and these will represent the specialists in the subject, a general knowledge of what agriculture has meant in the past, is meaning to-day, and must mean in the future. To accomplish this, as I see it, some knowledge of technical processes is necessary, some contact with the soil is desirable, and some study of practical agricultural methods is essential, but let us be quite clear that this is only a small

part of the whole study, which will demand far deeper inquiry and far wider reading than is usual among students of agriculture in the Universities. As far as I know, no University has had an end of this kind in view in framing its agricultural curriculum. The curriculum at Cambridge is largely a modern development of the older methods adapted to suit the needs of that University, and to train men to become managers of land. We in Oxford, have had that view in mind also, but we have I think gone further towards developing a course of study along the lines I have indicated. An undergraduate at Oxford may take for his final examination in Agriculture three subjects, (1) Agriculture from the practical and technical side, (2) Economic Theory and the Economics of Agriculture, and (3) History of Agriculture in Great Britain and Ireland and Comparative Agriculture, this last signifying a study of current conditions in the more important agricultural areas of the world. A study such as this seems to me to form the foundation of such a curriculum as I have in mind and to represent more nearly than anything else a non-vocational agricultural education. This study will demand from the student some knowledge of physical science in order that he may understand the technical, that is, the manufacturing, process, for it is impossible to understand even in the most general way the relations of soil and plant, plant and animal without some scientific training, and this student of mine must be able to have an intelligent opinion about present practises and future developments. It is not, however, on the side of physical science that most of his work will lie. The chief development, as I see it, will consist in a wider and deeper study of economic science so that finally his knowlede of agriculture will include not only the history of the industry in this country, but in the world as a whole, and will be a study of economic history and economic geography of the first importance. An interesting new departure has been made by the University of Bristol in introducing the study of Agricultural Economics as an optional subject for the Final Honours Degree in Economics. This is all a move in what I consider the right direction, but for my part I would go still farther and make a study of the economics of British Agriculture not optional, but compulsory, for those taking a degree of this kind.

Such a course as I have tried to indicate would then run side by side with the ordinary vocational and professional course, and would, I hope, in time be taken by a large number of persons who had no intention of engaging in practical agriculture, but who would form a nucleus of informed opinion that could not fail to produce an effect upon the fortunes of the industry and upon the rural life. Thus, even more perhaps than by creating a class of farming landlords who would play to-day the part played by their predecessors of the eighteenth century, would it be possible to recreate the countryside, to build up a new rural order, under the enlightened leadership of thoe who have studied fully and carefully the problems of country life and the problems of country industry as they have varied throughout the centuries.

I have ventured to put before you what I believe to be the great needs of the agricultural community—greater light in its own ranks and a public better informed of the needs of the industry and of its own requirements in the matter of essential supplies. It may be urged that much of what I have said is unreal and bears little relation to facts as they are, and, above all, offers no immediate help to the farming community in its present need. This last I admit is true. Others with more practical experience are attempting that almost daily. Some indeed would soothe the sufferings of agriculture with drugs which can afford but a temporary relief and, without the trouble, lull the sufferer into a false sense of security. I have tried to go beyond this, and in so doing have come to the conclusion that what is most fundamentally vital to the industry and to the whole body corporate is a new attitude of mind towards education and a true realisation of the value of cultural studies as distinct from vocational training, the worth of which all would, I trust, readily acknowledge. If, and when, this realisation comes to pass there will, I believe, develop all over the English countryside a class of landowners who are informed about country affairs, a class of farmers who are able and willing to pay rates of wages comparable to those which can be obtained in other industries, a class of workmen who by theirr skill and the value of their output make this rate of wages possible, and a general community which realises the value to itself of a flourishing agriculture, and is capable of thinking intelligently about the future of that industry, and of facing with knowledge the problems of its own food supply. Then, and only then, shall we be able to build up the new rural civilisation of which so many have dreamed.

WAVE-LENGTH MEASUREMENTS IN THE ARC AND SPARK SPECTRA OF ZIRCONIUM.

By C. C. Kiess.
(U.S.A. Bureau of Standards.)

The arc and spark spectra of zirconium as emitted between electrodes of pure zirconium metal were photographed with the concave grating and quartz prism spectrographs of the Bureau of Standards. The measured wave lengths in the arc spectrum cover the region from 4881 A in the blue to 9277 A in the infra-red, thus extending our knowledge of the spectrum more than 2,000 units beyond the longest Zr wave length heretofore observed. The arc spectrum in the regions investigated is superposed on a band spectrum in which the bands are shaded towards the red. The wave-length measurements of the spark spectrum extend from 2163 A in the utra-violet to 6115 A in the red, and contains not only the lines of the singly ionised atoms, but also those of doubly and trebly ionised atoms.

For more than a decade the spectroscopy section of the Bureau of Standards has had, as a major portion of its program, the measurement of standard wave lengths in the spectra of the chemical elements. In particular, this work has been concerned with the extension of our knowledge of spectra into those regions which have been but poorly or not at all observed, namely, the red and infra-red, as far as present-day photographic processes will permit. But the progress which recent years have seen in the analysis of complex spectra into their series relationships has demonstrated the need of a careful revision of the existing wave-length material, especially of the rarer elements. These objects have been attained for the element zirconium, atomic No. 40; and it is the purpose of this paper to present the wave-length measurements which have been made in its arc spectrum from 4881 A in the blue to 9277 A in the infra-red, and in its spark spectrum from 2163 A in the ultra-violet to 6115 A in the red.

The earlier investigations on the arc and spark spectra of Zr are described in Kayser's Handbuch, Volume VI. Since the appearance of that work in 1912 five papers dealing with measurements of Zr wave lengths have been published. These are by: (1) Eder, for the limited region in the red from 6470 A to 7341 A; (2) Vahle, for the entire region accessible to him photographically from 2285 A in the ultra-violet to 7208 A in the red; (3) McLennan and Lewis, whose measurements extend from 1656 A to 1854 A in the Schumann region; (4) Bowen and Millikan, who present seven new lines in the extreme ultra-violet, together with their series classification; (5) McDonald, Sutton, and McLay, whose measurements in the arc and spark spectra extend from 1866 A to 2164 A in the ultra-violet. In 1923 announcement was made of the discovery of a new element, atomic No. 72, and subsequently named hafnium, which resembles Zr in its chemical properties and is closely associated with it in nature. A full account of the occurrence and properties of hafnium has been published by G. von Hevesy, co-discoverer of it with D. Coster. Its optical spectrum has been measured by Hansen and Werner. Comparison of their Hf wave lengths with existing tables of Zr lines has shown that numerous faint lines ascribed to Zr are in reality the stronger Hf lines.

Experimental Procedure.

The spectrograms upon which the present investigation is based were secured with the concave grating and quartz prism spectrographs of the Bureau of Standards. The gratings and the method of mounting them have been described in earlier papers. The quartz prism spectrograph is Hilger's type E 1.

For the region from 2100A to 2400 A, the quartz prism spectrograph was employed, the dispersoon ranging from 1.46 A per mm to 2.25 A per mm. The spectrograms were obtained on Schumann plates supplied by Hilger. For the spectral regions from 2300 A to 9300 A the grating spectrographs were used. The first order of the 20,000 lines-per-inch Rowland grating was used to photograph the regions from 2300 A to 3100 A and from 4900 A to 9100 A. From 3000 A to 5500 A the second order of this grating was used. The dispersions were 3.6 A and 1.8 A per mm, respectively, for the first and second orders. The Anderson grating with 7,500 lines per inch, giving a dispersion of 10.4 A mm in the first order, was used to photograph the spectrum from 5500 A to 9300 A. The Anderson grating gives much brighter images thas the Rowland grating and was used exclusively for making the longer exposures which ranged from one to four hours.

The spectrograms with the Rowland grating were photographed on Schleussner ultra-rapid plates 40 cm long by 6 cm wide.

These plates were about 1 mm. in thickness, and accordingly could be bent to fit the focal curve of the grating. With the Anderson grating flat places 20.5 cm. long by 6.5 cm. wide were used to photograph the spectra. To render the plates sensitive to the green, yellow, red, and infra-red portions of the spectrum, they were bathed in solutions of pinaverdol, pinacyanol, dicyanin and neocyanin, respectively, by the well-known method.

The light sources were arcs or sparks maintained between Zr electrodes. The arcs were operated on 240 volts d.c., at current strengths ranging from 4 to 7 amperes. The spark discharge was supplied by a transformer which stepped up 110 volts a.c., to 40,000 volts. A condenser 0.006 μf capacity was connected in parallel across the high-voltage terminals of the transformer. Exposures to the spark were always tuxtaposed to arc exposures, and these in turn to exposures to the Fe or Cu arcs which furnished the comparison spectra. On some of the plates the neon spectrum also was photographed to serve as a comparison spectrum.

The material used in the electrodes for the earlier Zr exposures was Kahlbaum's preparation of zirconium nitrate. It was burned on cored copper rods. But for the later spectrograms, which constitute the majority of the series, the electrodes were rods or small lumps of Zr metal which was kindly supplied to us for spectrographic analysis by three different donors, namely, Prof. M. A. Hunter, of Rensselaer Polytechnic Institute; Dr. L. M. Beckett, of the Electrometallurgical Co.; and Dr. H. C. Rentschler, of the Westinghouse Research Laboratory.

All the spectrograms were measured on the large measuring machine which has already been described. The plates were measured in the direct and reversed position, the recorded redings of the micrometer head being the means of from 4 to 12 settings on the spectrum line. The reference lines were selected from the iron or neon spectra except in the ultra-violet where the Cu lines measured by Mitra were used. For valnes of the Fe wave lengths the results of Meggers and Kiess were used in the region 6750 A to 8824 A; for the region 3370 A to 6700 A the wave lengths determined by Meggers, Kiess, and Burns were used; and for the regions extending from 2300 A to 3400 A the values determined by Burns were adopted. The Ne wave lengths are those measured by Burns, Meggers, and Merrill.

BIRMINGHAM UNIVERSITY NEW BIOLOGICAL BUILDINGS.

British School of Malting and Brewing and Department of Bio-chemistry of Fermentation.

Historical.

The department was founded at an earlier date than the incorporation of the University of Birmingham. Accordingly, at first, it was a department of Mason University College.

The School was formally declared open by Mr. H. Cosmo O. Bonsor, M.P., on Thursday the 18th January, 1900. The late Professor Adrian Brown had been appointed, and held the position until his death in 1919, the School being maintained during that interval by contributions from the brewing industry. After the death of Professor Brown, a further appeal was made to the brewing industry, with the result that a full endowment was provided for the chair, to which the name of Adrian Brown is attached.

The New Laboratories.

The department consists of a series of 16 rooms running from east to west. There is a spacious general laboratory, a well appointed microscope room and a research laboratory. The Professor and the lecturer have each a private room and a laboratory assigned to them, and there is a special laboratory for analysis, and incubator rooms and dark rooms for photography and polarimetric work. The new departmental library will contain all the books in the University in biochemistry of fermentation. The laboratories are well equipped with the latest forms of apparatus, and they are unquestionably the best and most up-to-date of their kind in the country.

Research.

One of the objects of the School is to advance research in the many fields open to investigation in connection with the fermentation industries, and the Professor possesses wide powers with regard to aiding the investigations of competent workers by finding accommodation in his laboratories, and in other ways. Applications concerning such questions should be made to the Professor direct.

Professor Adrian Brown's research work is well known. It dealt with studies on micro-organisms—bacteria and yeasts—and the products of their action on different substances. He studied specially alcoholic fermentation, and made many notable contributions to the chemistry of enzymes.

The high reputation of the Department for training and research built up by the late Professor Adrian Brown has been well maintained during the eight years which have elapsed since his death. A large number of papers dealing principally with the carbohydrates have been published. Among these may be mentioned papers on the chemistry of Starch. In the first of this series, reliable methods have been described for the estimation of Starch in Barley, Wheat and Potatoes, and these methods are now in use at Agricultural Institutions and generally in Malting and Brewing Research. Several papers have been published describing studies on the products of the hydrolysis of starch by enzymes, as a result of which much light has been thrown on the nature and constitution of starch itself and of the products which are formed during the mashing process in practice. In view of the fact that Chemists have been working at this it is too much to expect that finality has now been reached. These studies which are now being continued in the Department, have added considerably to our knowledge and have opened up fresh paths, the exploration of which cannot fail to bring forth fruitful results.

In addition to the work on starch, researches have been conducted on Glycogen, Pectins, and Hemicelluloses and on various other subjects.

Careers.

The aim and object of all students is to gain sufficient knowledge—and that of the right kind—to enable them to obtain appointments after their University training. The question may be asked : Will the training in the Department secure this object? The answer is not far to seek. Since all the metabolic changes occurring during the life of an organism may be classed as fermentation, whether they be exothermic or endothermic, the study of fermentation in its broadest sense, is fundamental in regard to biochemistry, physiology and pathology. In proof of this assertion the work of Pasteur need only be cited. A student who has obtained an Honours degree or a Diploma, or both, will have received therefore so sound a training that he should have no difficulty in obtaining immediate employment after leaving the University, and facts could be cited to show that is actually the case. Students of the School who have availed themselves of the full curriculum have as a rule secured first-class appointments—and some of them are now heads of Departments. What are these appointments? First of all there are appointments in Breweries, Distilleries, and Vinegar Breweries—either as Chemists in these industries or as Technicians. The Technician now required in these industries is no longer an empiricist, but he must know the scientific principles of his daily operations in so far as these have been ascertained. The department deals with Agriculture, and cognate industries; Chemistry and Bacteriology as applied to Food and Drugs; Water Supply, etc. The present head of the Department is Professor A. R. Ling.

Botanical Department.

The new Botanical Department, comprising some thirty-three rooms, occupies the second floor of the new block, as well as the eastern portion of the first floor. On the first floor are sterilising and incubating rooms for mycological work, staff and preparation rooms, and the herbarium. Mycology is the branch of Botany which deals with Fungi, many of which are harmless or even beneficial, while others give rise to diseases of living crops or of timber, and sometimes even of animals. The new laboratories are especially fitted for studying fungi by the method of pure cultures. The herbarium contains a number of important collection, being particularly rich in lower plants. These collections are now in process of arrangement.

The eastern end of the second or main floor is designed chiefly (though not exclusively) for teaching purposes, and the western end for research. Between these two parts, conveniently placed for both, are the departmental library, museum, store rooms, etc. As far as possible, the laboratories and staff and other rooms in which microscope work is carried on, have been arranged on the north side of the building, as a north light is the best for microscope work.

Special provision has been made for the study of plant physiology, one of the most important branches of modern Botany. The physiological laboratory is a large, well-lighted room at the extreme eastern end of the department. It extends across the entire width of the building, being provided with north and south windows as well as three large roof lights. Adjacent to this laboratory are a small chemical laboratory and a physiological dark room; these allow of the application of exact chemical and physical methods to the study of living

plants. For experiments in which open air is necessary, a working bench of concrete and lead has been erected on the roof. This bench ,like the ordinary laboratory benches, is provided with water, gas and electric current, and communicates with the physiological laboratory below. In many cases it will thus be possible to record by means of delicate instruments in the quiet laboratory below, the results of experiments performed on living plants exposed to sun, wind, etc., on the roof above. To carry on physiological work, whether teaching or research, adequately, it is necessary to supplement laboratory facilities by experimental grounds and greenhouses. At present these are lacking, and the department has to rely on the Edgbaston Botanical Gardens, inconveniently situated at a distance of some miles. It is hoped that in the near future the necessary facilities will be available in the University grounds themselves.

The senior morphological laboratory and the junior laboratory are situated on the north side of the building, adjacent to the physiological laboratory.

Most of the rooms at the western end of theh second floor are fairly small; they include several staff and other research rooms, an "Honours" room, and photographic rooms. Nowadays, photography forms an essential part of the technique of scientific Botany, both for teaching and research. To meet these requirements, a well-equipped photographic dark room and a photographic studio have been provided. The latter is well lighted (with provision for controlling the light) and contains a large photomicrographic apparatus.

In designing the equipment of the new Botanical Department, special care has been taken to provide as far as possible for the avoidance of vibration where delicate apparatus is concerned. Slate or thick teak slabs, supported by cantilevers embedded in foundation walls, have been provided in the physiological laboratory, in all staff and other research rooms, and for the photomicrographic apparatus. Similarly, the legs of all microscope benches rest on solid concrete foundations and not on the wooden floors.

The University now possesses a very useful botanical library, which in recent years has been greatly improved and extended. Most of the botanical periodicals, books and pamphlets will be housed in the new departmental library. It will be a great advantage especially to research and other advanced workers, to have the necessary literature so readily available.

In addition to the building and its fittings, a considerable sum of money has been set aside for apparatus. It may fairly be claimed that the new Botanical Department will be well equipped and up-to-date. At all events, conditions will be greatly superior to those of the crowded, badly-lighted quarters in Edmund Street which have just been vacated. In particular, the facilities for research will be vastly improved. Already upwards of 150 botanical papers or books have been published from the Botanical Department, many of them by the late Professor G. S. West, an algologist of world-wide repute. At the present time research is being actively prosecuted under the direction of the present holder of the Chair, Professor R. H. Yapp, and his staff, in several branches of Botany, including physiology, ecology and mycology. Under the new conditions it is confidently hoped that these activities will be extended.

So far as teaching is concerned, provision is made in the new Department for the needs of various classes of students. There are special courses for medical and dental students, as well as for students in the Department of Brewing and Biochemistry of Fermentation. But the main part of the teaching work of the Department consists in the training of students of pure science. The number of students presenting Botany as a principal subject for the Degree of B.Sc. in the University of Birmingham has steadliy increased during the last seven or eight years, and there is also a vigorous Honours School of Botany.

The number of posts now open to keen and able students who have specialised in Botany or in one or other of the applications of this science is considerable. The teaching profession offers many opportunities. This has been the case in girls' schools for many years, and is increasingly so in boys' schools, though as yet the practice found in many parts of the Continent of including Botany in the curricula of all schools has not been adopted in this country. In addition to teaching, there are now a considerable number of research and other posts available, both at home and abroad. For instance, there are many appointments open (as vacancies arise) to properly trained, competent botanists in the colonies and Protectorates. These include posts as Directors of Botanic Gardens, Mycologists, Plant Physiologists, Plant Breeders, Economic

Botanists and so on. A number of post-graduate Colonial Agricultural Scholarships also have recently been instituted. For many of these Botany should be one of the subjects taken as part of the Degree Course of a Candidate.

GENERAL NOTES.

ROYAL INSTITUTION.

A general meeting of the members of the Royal Institution was held on Monday afternoon, November 7, Sir Arthur Keith, Treasurer and Vice-President, in the chair. The Secretary reported that the Institution had received a legacy from the late Sir W. Phipson Beale, M.R.I. The deaths of Lord Inveagh, M.R.I.; Prof. Mittag-Leffler; and of Prof. Arrhenius, Hon.M.R.I., were announced and resolutions of condolence with the families were passed. Mr. Bright, Mr. H .Gill, Mr. A. H. Jenkin, Mrs. A. Patrick, Mr. E .B. Robertson, and Mr. M. Ruffer were elected members.

THE MANCHESTER SECTION OF THE OIL AND COLOUR CHEMISTS' ASSOCIATION.

Annual Dinner.

The section will hold its third annual dinner at the Grand Hotel, Aytoun Street, Manchester, on Saturday, December 3, 1927, dinner 7 p.m.

The Committee trust that members will give them all possible support at this the principal social function, held annually by the section. The presence of ladies will be welcomed.

We learn that a number of well-known representative guests have already accepted the invitation of the Committee to be present. The dinner will be followed by a musical programme.

TO MEET IN SOUTH AFRICA IN 1930.

The Empire Council of the Mining and Metallurgical Institution states that a cordial invitation to assemble in South Africa in 1920 was conveyed personally to the Congress by the Honourable F. W. Beyers, Minister of Mines and Industries, on behalf of the Prime Minister and Government of the Union of South Africa. The invitation was received with enthusiasm by the Congress and was duly accepted by the Empire Council.

EMPIRE COUNCIL OF MINING AND METALLURGICAL INSTITUTIONS.

Important Function to be Held in London.

The Empire Mining and Metallurgical Congress in Canada, which was a brilliant and unqualified success in every way, held its closing session in Quebec at the end of September, when votes of thanks to the Dominion and Provincial Governments Municipalities, and the numerous other official and private hosts were enthusiastically adopted.

At a meeting of the Empire Council of Mining and Metallurgical Institutions, at which official delegates to the Congress from the Constituent Institutions were present held on the same day, it was unanimously decided that a dinner be held in London to afford an opportunity of acknowledging the indebtedness of the Constituent Institutions to the Canadian Governments and people and to review the results of the Congress the importance of which to Canada and the Empire generally was universally acknowledged.

The members are invited to a dinner to be held on Tuesday, November 22, at the Hotel Victoria, Northumberland Avenue London, W.C., at 7.15 for 7.45 p.m., to meet The Hon. Peter C. Larkin, High Commissioner for the Dominion of Canada; the Right Hon. Sir Robert S. Horne, K.C. M.P., Honorary President of the Congress and other distinguished guests.

THE MISCELLANEOUS NON-METALLIC PRODUCTS INDUSTRY IN CANADA IN 1926.

According to a statement issued by the Dominion Bureau of Statistics at Ottawa production from the 31 plants in Canada classified under the Miscellaneous Non Metallic Mineral Products Industry amounted in value to $8,612,658 as compared with an output value of $7,978,183 in 1925. This industry included 11 establishments manufacturing artificial abrasives or abrasive products, 2 plants making graphite electrodes, 7 concerns producing gypsum products, 9 mica-trimming shops, and plants making foundry supplies.

FRENCH FOREIGN TRADE.

Imports into Franch during the first none months of the year show nearly 13 per cent. decrease in value as compared with January and September ,1926, while exports from the country declined nearly 6 per cent. The balance of trade for the period was favourable, however, to the extent of 1,755 mllion francs, whereas a year ago there was an import excess of 1,484 million francs.

GERMAN TRADE IN SEPTEMBER.

An unfavourable trade balance amounting to 242.1 million marks was recorded by Germany in September last, as against 292.2 million marks in August. Exports, as a result of the heavy increase in finished goods, which were the largest since the war, showed an advance of 64 million marks.

SHIPPING MOVEMENTS AT BRITISH PORTS.

As was the case in the previous month, there was an all-round increase in tonnage arriving at or departing from United Kingdom ports in September as compared with the same month of 1925.

CANADA'S MINERAL WEALTH.

In the past twenty years the estimated value of the annual mineral production of Canada has increased by nearly 300 per cent. to close upon £50 millions. Further, the output per capita in 1926 was about 26½ dollars as compared with only 3½ dollars in 1890.

DUTCH ARTIFICIAL SILK EXTENSION.

The British Commercial Secretary at The Hague informs the Department that, according to the *Algemeen Handelsblad*, the board of directors of the Netherlands Artificial Silk Factories have decided to extend the factory at Arnhem to about double its present size. This will necessitate the employment of a further 1,000 persons.

PAINLEVE—THE EDUCATOR.

It may appear paradoxical that Painlevé, scientist, mathematician, man devoted to teaching and desirous of peace, should accept the position of Minister of War.

Will a time come when the war office can be abolished with security? Painlevé is a practical idealist, foreseeing, fore-planning. He proved it in 1914 when so much of the armament ready for the Army, the Navy, and the Air Force were due to his forethought and his energetic action. He proved it even 19 years ago when he made his brilliant campaign in favour of aviation and took his place next to Wilbur Wright in one of his longest flights—one hour, ten minutes, at a time when heavier than air machines were still in their infancy, and the serious accident of Orville Wright risked bringing them in disfavour.

Painlevé's interest in aviation remain unabated, both from a mechanical and practical point of view. When he arrived in England on the 15th, it was of course at Croydon, in a French military 'plane.

His visit to this country is purely personal and what appeals to him more than all other—that of education. He said in 1914 : "Je voudrais que lorsque l'être que je suis se dispersera dans le grand infini, ce fût le sentiment de tous ceux qui m'auront connu que toujours, de toute ma vie, de toutes mes forces, j'ai essayé d'être un éducateur."

Education is the great problem, the great reform to be brought about—education for all, education in the broadest sense. Painlevé the scientist, the mathematician, the scholar, gifted to an exceptional degree in so many spheres, of high moral purpose and prodigious in his capacity for work, subjects all his diverse talents to his patriotic duty, the education of the fellow-countrymen. "Convinced," says Daniel Berthelot, himself a great scientist, "that the spirit of science must animate all modern society, he (Painlevé) can be heard alternately, at Paris and in the suburbs, addressing meetings of the 'Association philotechnique,' 'Union de la Jeunesse,' and the Universités populaires.' Only those who have listemed to his lectures on astronomy, on wireless, on Galileo, on Copernicus, on Jean Jacques Rousseau, know how harmoniously are united in his warm and powerful wirds, the most vared resources in art and poetry and the severe deductions of logic."

Painlevé was born in Paris in 1863. His name indicates his remote Breton ancestors and is a deformation of the Breton "pen," meaning head, and "Leven,"—competency, wealth. His father belonged to one of the old Parisian families of draughtsmen and printers and it was at an elementary school that Paul Painlevé re-

ceived his first instruction. He has remained touchingly faithful to his origin and willingly places the sum of his masterly knowledge within the reach of all, whether it be at the peoples' colleges where he talks to workmen at the end of their daily labour, or to the highest scientific institutions and greatest universities in the world.

This is the man that Cambridge honoured on the 16th of this month. The degree of Doctor of Science, *honoris causa*, was bestowed on him there, and the famous Senate Hall was thrown open to hear him speak. It is a great scientist who is coming to England, and during his short stay of three days, he spoke three times in the cause of science, at the Royal Institution, at Cambridge, and at the French Institute in South Kensington where, at the official home of French learning in this country, he will once again be lecturing in his own territory.

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

The following papers were read on Thursday, November 10 :—

The Origin of Speech. By Sir Richard Paget. Communicated by Sir William Bragg, F.R.S.

In view of a previous conclusion, that the significant element of speech is gesture of articulation rather than sound, a number of " words " were fabricated by making pantomimic gestures of tongue and lips to imitate simple actions. Out of a list of 10 fabricated words ,Dr. N. Whymant found close equivalents in 9 cases from early Polynesian, Melanesian and Japanese speech. Thus the fabricated word for " reach up " was dd, or aθ—the actual words (of similar meaning) were ddd, or dddru, iddru.

A study was made of the Aryan roots listed in Skeat's ' Dictionary of the English Language.' About 40 words were selected —such as AGH or ANGH (choke, strangle), BRAGH (break), LAGH (lie down), in which meaning was pantomimically related to gesture of articulation by which the word is produced. Further examination showed that each consonant imported a characteristic element of meaning, and that a primitive " word " was built up (like the Chinese deographs) by addition of significant elements; a primitive " word " was therefore equal in meaning to a modern sentence. This matter of word-formation was recognised in 1862 by Dr. Rae, of Honolulu, who described his theory in ' The Polynesian ' of September and October of that year.

Relation of Articulation to Phonation.—Phonation (range of sounds due to vibration of vocal chords) is a separate language, expressive of man's emotional state. The discontinuity of phonation in the case of the unvoiced consinants s, f, θ and ʃ therefore produces a discontinuity of emotional language.

Action of False Vocal Chords.—Observations made with the pharyngeal periscope of Prof. G. O. Russell of Ohio confirmed the view that the false vocal chords must be classed with the organs of articulation and are responsible for the essential differences between the so-called voiced consonants. b, d, g, v, z and their unvoiced counterparts p, t, k, f, θ, s, ʃ.

The Average Energy of Disintegration of Radium E. By C. D. Ellis and W. A. Wooster. Communicated by Sir Ernest Rutherford, P.R.S.

The average energy of disintegration of radium E is found by measuring the heating effect of a known amount of the material. It is found to agree with the mean energy of the continuons spectrum of electrons emitted from the nucleus, and the conclusion is drawn that the energy of disintegration is not a characteristic constant of a β-ray body but varies from atom to atom. The general bearing of this result on our views of the nuclens is discussed, and it appears that the γ-rays cannot be emitted by the eletcronic part of the nucleus but must have their origin in the positive portion.

On the Excitation of Polarised Light by Electron Impact. II.—Mercury. By E. T. S. Appleyard and H. W. B. Skinner. Communicated by Sir Ernest Rutherford, P.R.S.

The work is a continuation of that described recently by one of the present authors, in which it was shown that when spetcrum lines are excited by a directed stream of electrons, they are variously polarised. In the present paper measurements of the polarisation by means of photographic photometry are described. The aim is to obtain quantitatively the variation of the polarisation of the lines with the velocity of the exciting electron stream. The most

portant feature of the curves so obtained the maximum value of the percentage arisation which occurs when the energy the eleteron stream exceeds the critical ergy for excitation by a few volts. On the v-velocity side of the maximum, the polar-tion falls very sharply, apparently to a ro value at a critical point. For high locities, corresponding to 200 volts, the rection of the plane of polarisation is versed. The interest in the experiments s chiefly in the application of the results supply information about the collision rocess in which an atom is excited by elec-on impact, and an attempt is made to terpret the effects from this point of view.

THE PHYSICAL SOCIETY.

Proceedings at the meeting held on Friday, October 28, at the Imperial College of Scieuce, E. H. Rayner, M.A., D.Sc., in the chair :—

A Demonstration of an Improved Mercury Vapour Trap was given by Prof. G. I. Finch, M.B.E.

As a means for eliminating mercury vapour a thin film of sodium, deposited on the walls of a chamber, was proposed three years ago by Hughes and Poindexter; but this arrangement quickly loses its efficiency with use. The trap now demonstrated employs an alloy of sodium (one part) and potassium (two parts), which is liquid; all gases, except hydrogen and the inert gases, are absorbed by this alloy, and, in addition, mercury vapour forms a solid amalgam with high melting point. The alloy forms a pool at the bottom of a washing chamber. The apparatus can be flooded with coal gas and opened up frequently without deterioration, and the trap retains its efficiency for as long as a year.

For the purpose of the demonstration, two similar vacuum discharge tubes were alternately subjected to the same voltage, one of the tubes being in communication with a pump directly, the other through the trap. The latter was shown to be equivalent to a 10in. parallel spark-gap, the former to a 1in. gap.

The Theory of Liquid Flow Through Cones. By W. N. Bond, M.A., D.Sc., F.Inst.P., Lecturer in Physics, University of Reading.

Abstract.

This paper gives an approximate general solution of the hydro-dynamical equations for liquid flow through conical tubes of circular section, the errors due to the approximation being small for converging cones of small angle and for flow through similar diverging cones up to the speed at which the theory predicts turbulent motion. The theory is compared with experimental results previously published.

Discussion.

Dr. A. Ferguson : The Society is indebted to Dr. Bond for the solution which he has given of this very interesting problem. It would add much to the interest of his paper if he would compare his solution with one given by Professor Gibson in the Philosophical Magazine about 1909. Professor Gibson if I remember rightly, puts

$$v = w = \frac{\delta p}{\delta y} = \frac{\delta p}{\delta z} = 0.$$

so that the fundamental equations reduce to

$$-\frac{\delta p}{\delta x} = -\mu\left(\frac{\delta^2 u}{\delta x^2} + \frac{\delta^2 u}{\delta y^2} + \frac{\delta^2 u}{\delta z^2}\right) + \rho u.\frac{\delta u}{\delta x}$$

which, transferred to polar co-ordinates x, θ. integrates quite readily. This solution was not discussed in such detail as Dr. Bond's, and a comparison of the simplifying assumptions made wonld not be without interest.

The Structure of the Smoke Particles from a Cadmium Arc. By H. P. Walmsley, M.Sc.

Abstract.

Using the powde rmethod of X-ray analysis, the particles dispersed in air from a cadmium arc are found to be isometric crystals of cadmium oxide. From X-ray data, a density of 8.16 was obtained for the primary particles in the smokes—the normal density of cadmium oxide. Photometric measurements of the breadth of the lines showed that the primary crystals were of colloidal dimensions, values of 5.8×10^{-6} cms. being obtained in two cases. On aggregation, the ultramicroscope crystals are shown to grow along binary axes of symmetry—*i.e.*, they tend to unite on their 110 faces. Photomicrographs of the deposits obtained from cadmium oxide smokes are shown, together with models of aggregates built on these lines. The models give many of the characteristic structures which are observed in the complex partices. Previous measurements on the smoke particles are discussed in the light of these results.

SOCIETY OF PUBLIC ANALYSTS.

An ordinary meeting of the Society was held in the theatre of the Institute of Pathology and Research, St. Mary's Hospital, at the invitation of that Institute, Mr. E. Richards Bolton, President, being in the chair :—

Certificates were read for the first time in favour of Messrs. Alfred Harry Bateman, B.Sc., A.I.C.; Arthur Owen Blackhurst, M.D.; William Clayton, D.Sc., F.I.C.; Charles William Cornwell, B.Sc., A.I.C.; and Thomas Riley, A.I.C.

Certificates were read for the second time in favour of Messrs. Leslie V. Cocks, A.I.C.; Frederick Dixon, B.Sc., A.I.C.; David Michael Freeland, A.I.C.; Desmond Geoghegan; Claudius George Hyde, A.R.C.Sc., F.I.C., Vernon James Tilley, F.I.C., Leonard Wild, B.Sc., and Hugh A. Williams.

The following were elected members of the Society :—Messrs. Charles Edwin Corfield, B.Sc., F.I.C.; Harold E. C. Powers, B.Sc., A.I.C., John David Rogers, and Abraham Samson, A.R.C.Sc., A.I.C.

The Biological Tests for Blood. By Sir William Willcox, K.C.I.E., M.D., F.I.C.

An outline was given of the evolution of blood tests, from the days when the only differential method available was based on differences in the form and size of the blood corpuscles, down to the refined serum tests of the present time. The author described his technique for examining blood stains, and illustrated his method of filtering the stain extract before applying the serum tests. He advised great caution in using bought specific sera for these tests, since they were frequently inert.

The Technique of the Precipitin Test and its Forensic Value. By G. Roche Lynch, O.B.E., MB., B.S., D.P.H.

After a summary of the theory of antigens in the blood of a living animal, and an account of the properties of anti-bodies, the author described the various methods of preparing anti-sera, the extraction of blood stains, the filtration and sterilisation of the extract by means of special apparatus, the methods of determining the concentration of the extract, and the various ways in which the precipitin test could be applied. The precautions required and the limitations of the test were discussed, and various possible applications of the serum test in the examination of foods were given.

The Use of the Blood Grouping Reaction in Forensic Investigation. By F. C. Martley, M.A., M.D., F.R.C.P.I.

The theory and technique of blood agglutination tests were discussed and demonstrated, and the author showed how, by means of the four blood groups in which the blood of different individuals could be classed, it was often possible to distinguish between the blood of different persons. Various applications of the method in forensic work and in determining paternity were pointed out.

FORTHCOMING EVENTS.

CHEMISTRY INDUSTRY CLUB.

2, Whitehall Court, London, S.W.1.

Monday, November 21.

FARADAY SOCIETY.

13, South Square, Grays Inn, London, W.C.1.

Wednesday, November 23. A General Discussion on "Cohesion and Related Problems."

ROYAL INSTITUTE OF PUBLIC HEALTH.

37, Russell Square, London, W.C.1.

Wednesday, November 23, at 4 p.m.—"The Prevention of Heart Disease." By A. Dingwall Fordyce, M.D., F.R.C.P.Ed.

ROYAL INSTITUTION OF GREAT BRITAIN.

21, Albemarle Street, London, W.1.

Tuesday, November 22, at 5.15 p.m.—"A Year's Work in X-ray Crystal Analysis." By Sir William Bragg, K.B.E., Ll.D., F.R.S.

Saturday, November 26, at 3 p.m.—"Samuel Wesley and Robert Pearsall." By Gustav Holst. (With musical illustrations.)

ROYAL SOCIETY OF ARTS.

John Street, Adelphi, London.

Monday, November 21, at 8 p.m.—(*Cantor Lecture*). Professor Henry C. H. Carpenter, M.A., Ph.D., F.R.S. : "Alloy Steels, their Manufacture, Properties and Uses." (Lecture II.)

Wednesday, November 23, at 8 p.m.—(*Ordinary Meeting.*) T. Hedley Barry : "Malayan Resins." A. F. Suter, Esq., will preside.

SOCIETY OF CHEMICAL INDUSTRY.

Birmingham and Midland Section, The Chamber of Commerce Buildings.—Thursday, November 24.—"Notes on the Chemistry and Physics of Stone Decay." By A. R. Warnes.

SOCIETY OF GLASS TECHNOLOGY.

Tuesday, November 22, at 7.30 p.m.—Popular lecture to the Glass Workers of Stourbridge and District : "Modern Artistic Glass." By Prof. W. E. S. Turner. In *the Congregational Schoolroom, Lower High Street, Stourbridge.*

Wednesday, November 23, at 2.30 p.m.—At the Talbot Hotel, Stourbridge : "Fire Clays as Applied to the Glass Industry." by M. H. Edwards. "Glass-Pot Manufacture in Great Britain," by Prof. W. E. S. Turner. "The Homogeneity of Glass Melted in Pots," by Mrs. G. A. Green (Edith M. Firth) and Prof. W. E. S. Turner. "The Effect of Iron Oxide on the Properties of Glass," by Dr. S. English, H. W. Howes, M.Sc.Tech, and Prof. W. E. S. Turner.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, London.

Monday, November 21, at 7 p.m.—Informal meeting. Automatic Telephony. To be opened by W. Day.

South Midland Centre, Birmingham.—Friday, November 25. Annual Dinner at the Grand Hotel.

UNIVERSITY COLLEGE.

Gower Street, London, W.C.1.

Wednesday, November 23, at 5.30 p.m.—"The Report of the Departmental Committee on Libraries." A public lecture by Mr. C. O. G. Douie.

Thursday, November 24, at 5.30 p.m.—"The Air Force in Home Defence." A public lecture, with lantern illustrations, by Air-Marshal Sir John M. Salmond, K.C.B., C.M.G., D.S.O. Chairman : The Secretary of State for Air, The Rt. Hon. Sir Samuel Hoare, Bt., C.M.G., M.P.

Friday, November 25. — University of London Officers Training Corps : Night operations.

New Patents.

These particulars of New Patents of *interest to Readers have been selected from* the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

28,784.—Hartley, G. S.—Crucible fork and stand. October 28th.

28,220.—Holzverkohlungs Industrie Akt.-Ges. — Production of acetone. October 27th.

28,616.—I. G. Farbenindustrie Akt.-Ges.—Manufacture of stable solid solutions of salts of aromatic sulphonic acids. October 27th.

28,388.—Chemische Fabrik auf Actien vorm. E. Schering.—Manufacture of alkyliso-proplyphenols, etc. October 25th.

28,444.—I. G. Farbenindustrie Akt.-Ges.—Production of cellulose acetate solutions, etc. October 26th.

Specifications Published.

258,296.—I. G. Farbenindustrie Akt.-Ges.—Process for treating decamphorated oil of turpentine.

268,728.—U.S. Industrial Alcohol Co.—Process of dehydrating alcohol by distillation.

278,307.—Commercial Solvents Corporation. Art of butylacetonic fermentation.

276,307.—I. G. Farbenindustrie Akt.-Ges.—Method of maintaining the stability of dibasic calcium hypochlorite.

Abstract Published.

277,098.—Naphthalene derivatives.—I. G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany.

Aralkylated naphthylalkylethers; sulphonic acids. — Naphthylalkylethers are aralkylated in the nucleus by treating them with aralkyl halides, *e.g.*, benzyl chloride or xylyl chloride, preferably in the presence of a catalytically acting metal. The products

are more or less viscous oils which, on sulphonation, yield water-soluble sulphonic acids useful as wetting agents for animal and vegetable fibres. In an example, β-naphthol-isoamylether is heated with benzyl chloride in presence of iron filings and the product is sulphonated.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

HARLE.QUIN.

483,546.—Chemical substances prepared for use in medicine and pharmacy. J. E. Ellis, Ltd., Lister Laboratories, Station Road, Horsforth, near Leeds, Yorkshire. October 26th.

LIONISER.

483,817.—All goods in Class 3, which includes chemical substances prepared for use in medicine and pharmacy. —Wright, Crossley & Co., Ltd., 60, Lincoln's Inn Fields, London, W.C.2., and 17, North John Street, Liverpool. October 26th.

KEMKRAFT.

484,461.—Chemical substances prepared for use in medicine and pharmacy.—Gordon Steward Galloway, trading as Galloways, 79, New Street, Birmingham. November 2nd.

CAFIRIN.

484,624.—Chemical substances prepared for use in medicine and pharmacy.—Bayer Products, Limited, 31 to 34, Basinghall Street, London, E.C.2. November 2nd.

GERMAN CONVERSATION AND LESSONS GIVEN.

Translations Undertaken.

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THE USE OF π IN ATOMIC OPTICS—SOME FURTHER OBSERVATIONS.

By F. H. LORING.

In the *Chemical News* of November 18, 1927, p. 323, an attempt was made to justify the use of a modified π; or, in other words, true π with a modifying constant, so that the net result was π_s, as already given.

It has now been noticed that the constant K_1, given on page 326, can be evaluated from π and π_s as follows :—

$$\sqrt{[(\pi^2 10^3) - (\pi_s^2 10^3)]} = 3.7013 = K_1.$$

This implies that the equation is based upon the well-known theorem of Pythagoras (47th proposition of Euclid), so that the whole equation can now be written thus :—

$$(\dot{\pi} - \pi_s \cdot c) / \sqrt{(\pi^2 - \pi_s^2 \cdot 10^3)} = 1.76 \times 10^7 = e/m.$$

In must be remembered that in the writer's studies (1927) there are a number of whole-number multipliers, 10_a, where a may be a positive or negatve whole number; and, that a limiting line, suggesting the idea of limiting states, was used with an *air* value for its wave-length; but this latter fault can be eliminated by dealing only with Δ_a, and omitting Δ_H, especially as Δ_H has been assigned two distinct values, as will be seen by referring to the writer's articles on the "0.0153 displacement constant," published in this Journal during the current year. *Some of the values are purely numerical*, and attempts to regard them otherwise would be a mistake and lead to absurdities — at least so far as present knowledge goes. For this reason Δ_H was never given its usual full rendering.

BOARD OF TRADE ANNOUNCEMENT.

SAFEGUARDING OF KEY INDUSTRIES.
CALCIUM BIPHOSPHATE (BAKING POWDER QUALITY).

The Board of Trade have received a complaint under Section 1 (5) of the Safeguarding of Industries Act, 1921, that Calcium Biphosphate (Baking Powder quality) has been improperly excluded from the list, II ii, of articles chargeable with duty under Part I of that Act, as amended by Section 10 of the Finance Act, 1926. The complaint will be referred to arbitration to a tribunal constituted under Section 10 (4) of the Finance Act, 1926, and the date of the hearing will be announced shortly.

Any communications should be addressed without delay to the Principal Assistant Secretary, Industries and Manufactures Department, Board of Trade, Great George Street, London, S.W.1.

THE STRUCTURE OF AN ATOM OF NITROGEN.—V.

By HAWKSWORTH COLLINS, B.A., (Camb.).

The following Tables XXIX to XXXV demonstrate a fourth form of nitrogen. Its relative volume is 0.83; its Heat of Combustion (gas) is 20500, and its Heat of Formation (gaseous and solid) -20500. The aqueous Heat of Formation is -28630, the Magnetic Rotation 0.49 and Optical Refractivity 2.493.

For the explanation of any representation of figures that may appear obscure reference must be made to the four preceding papers on this element.

TABLE XXIX.

The Relative Volume of Nitrogen, 0.83.

		Theor. S.G. at 15° C.	Obs. S.G.	Corresponds with Nos.
(1)	CH_3NH_2 12.22 + 16.42 + 16.54 where 16.54 = 0.83 + 9.95 + 5.76	0.686	0.699	−11° Nostrand *i.e.*, 0.686 15°
(2)	$C_2H_5NH_2$ 15.25 + 2(16.42) + 16.54	0.696	0.696	8° Wurtz 101, 60, 66
(3)	$C_3H_7NH_2$ 15.25 + 3(16.42) + 16.54	0.728	0.722	15° Perkin 61, 67, 100, 107
(4)	$C_4H_9NH_2$ 15.25 + 4(16.42) + 16.54	0.75	0.755	0° Lieben
(5)	Isob.NH_2 15.52 + 4(16.42) + 2.27 + 16.54	0.732	0.724 0.736	20° Nostrand 15° Linnemann
(6)	$C_5H_{11}NH_2$ 15.25 + 5(16.42) + 16.54	0.764	0.763	20° Nostrand
(6A)	$C_5H_{11}NH_2$ 15.25 + 5(16.42) + 2.27 + 16.54	0.750	0.750	18° Wurtz 108, 62, 68
(7)	$C_6H_{13}NH_2$ 15.25 + 6(16.42) + 16.54	0.775	0.768	17° Pelouze *i.e.*, 0.77 15°
(8)	Isohex. NH_2 15.25 + 6(16.42) + + 2.27 + 16.54	0.762	0.759	25° Nostrand *i.e.*, 0.765 15°
(9)	$C_8H_{17}NH_2$ 15.25 + 8(16.42) + 16.54	0.79	0.786	Squire 109
(10)	$C_3H_5NH_2$ 58.29 + 16.54	0.762	0.7688	15° Nostrand
(11)	$NH_2(CH_2)_2NH_2$ 2(16.54) + 2(16.42)	0.910	0.902	Meyer 105
(11A)	$NH_2(CH_2)_2NH_2.H'_2O$ 2(16.54) + 2(16.42) + 14.03	0.975	0.976 0.970	25° Kahlbaum 15° Nostrand 105
(12)	$NH_2(CH_2)_5NH_2$ 2(16.54) + 5(16.42)	0.8856	0.8855	15° Perkin 106, 101a
(13)	$CO(NH_2)_2$ 8 + 4.45 + 2(16.54)	1.32	1.32	Nostrand
(14)	NH_2OH 16.54 + 2.51 + 5.76	1.33	1.35 1.227	Chem. Kal. 14° Nostrand
(15)	NH_2OH 16.54 + 4.45 + 5.76	1.234	1.227	14° Nostrand
(16)	$BrC_6H_4NH_2$ 27 + 6(0.71 + 4(15.25) + 16.54	1.58	1.58	21° Nostrand
(17)	2($CO.NH_2$) 2(8) + 7.53 + 2.51 + 2(16.54)	1.488	1.4756	31° Nostrand
(18)	$C_6H_5CH_2NH_2$ 77.48 + 16.42 + 16.54	0.990	0.990	14° Limpricht 102
(19)	$C_6H_5(CH_2)_2NH_2$ 77.48 + 2(16.42) + 16.54	0.954	0.959	25° Nostrand
(20)	$C_2H_6CO.NH_2$ 15.25 + 2(16.42) + 8 + 2.51 + 16.54	0.97	0.96 1.033	80° Nostrand 4° Schroder
(21)	p.$NH_2C_6H_4OEt$ 16.54 + 6(0.71) + 3(15.25) + 12.22 + 2,51 + 48.09	1.06	1.06	15° Nostrand
(22)	Xylidine 1.3.4. 6(0.71) + 3(15.25) + 2(16.42 +12.22) + 16.54	0.977	0.977	15° Nostrand
(23)	Et.O.NH_2 15.25+ 2(16.42) + 4.45 16.54	0.883	0.888	7.5° Nostrand
(24)	Formamide $HCONH_2$ 9.95 + 8 + 4.45 + 16.54	1.155	1.146	19° Gladstone 116 i.e., 1.15 15°
(24A)	$EtCO_2NH_2SC_5H_{11}$ 48.09 + 8 + 7.53 + 2.51 + 16.54 + 15.53 + 15.25 + 5(16.42)	0.97	0.9797	4° Claesson *i.e.*, 0.97 15°

(25)	$C_6H_5NH_3Cl$ 74.45 + 0.83 + 3(5.76) + 15.085	1.203	1.216	4° Schroder i.e., 1.205 15°	
(25A)	p.$ClC_6H_4NH_2$ 23.01 + 6(0.71) + 2(15.25 + 12.22) + 0.83 + 2(5.76)	1.348	1,340	18° Nostrand i.e., 1.344 15°	
(26)	$NiBr_2.6NH_3$ 11.53 + 2(27) + 6(18.11) where 18.11 = 0.83 + 3(5.76)	1.84	1.84	Nostrand	
(27)	$NiSO_4.7H'_2O$ 11.53 + 35.61 + 7(14.03)	1.93	1.93	Schiff	
(28)	NH_3NI_3 18.11 + 0.83 + 3(32.77)	3.5	3.5	Nostrand	
(28A)	$Cr_2(NH_3)_{10}Cl_6$ 2(8.71) + 10(18.11) + 6(15.085)	1.686	1.687	15.5° Jorgensen	
(29)	$Cr_2(NH_3)_{10}Cl_2Br_4$ 2(8.71) + 10(18.11) + 2(15.085) + 4(23.09)	2.071	2.072	18.8° Jorgensen	
(30)	Cr_2S_3 2(8.71) + 3(10.51)	4.09	4.09	Playfair	
(31)	$CoCl_3.6NH_3$ 4.05 + 3(15.085) + 6(18.11)	1.7	1.70	20° Nostrand	
(32)	$CoCl_3.5NH_3$ 4.05 + 3(15.085) + 5(18.11)	1.8	1.80	15° Jorgensen	
(33)	$CoCl_3.4NH_3.H'_2O$ 4.05 + 3(15.085) + 4(18.11) + 14.03	1.85	1.85	Jaeger	
(34)	$AmHC_2O_4.H'_2O$ 23.87 + 5.76 + 2(8 + 7.53 + 2.51) + 14.03 where 23.87 = 0.83 + 4(5.76)	1.567	1.556	Nostrand	
(35)	Am_2HPO_4 2(23.87) + 5.76 + 14.56 + 4.45 + 3(2.51)	1.65	1.678 1.619	Buignet Schiff	86
(36)	$AmHCO_3$ 23.87 + 5.76 + 8 + 7.53 + 2(2.51)	1.58	1.586	Playfair	72, 82
(37)	$AmHF_2$ 23.87 + 12.22 + 2(5.42)	1.21	1.21	12° Bodeker	
(38)	AmI 23.87 + 32.77	2.57	2.515	Chem. Kal.	77, 89, 94
(39)	$AmHSO_4$ 23.87 + 5.76 + 35.61	1.76	1.76	Playfair	84, 74
(40)	AmH_2PO_4(liq.) 23.87 + 5.76 + 8.59 + 16.87 + 4.45 + 2(.51) + 0.836	1.76	1.76	Schiff	79
(41)	AmH_2PO_4 23.87 + 2(5.76) + 16.87 + 4.45 + 3(2.51)	1.8	1.80	12° Nostrand	
(42)	Am_2HPO_4(liq.) 2(23.87) + 5.76 + 16.87 + 0.836 + 2(2.51) + 4.45	1.64	1.62 1.68	Schiff Buignet	78
(43)	$Am_2C_2O_4 + H_2O$ 2(23.87) + 2(8) + 2.51 + 3(4(45) + 18.02	1.455	1.461	Playfair	90
(44)	$Am_2SO_4.H'_2O$ 2(19.08) + 35.61 + 14.03	1.71	1.72	Dana	
	where 19.08 = 0.83 + 3(5.76) + 0.97	1.859	1.851	17° Nostrand	
(45)	$AmBF_4$ 19.08 + 15.7 + 4(5.42)	1.566	1.578	Playfair	91, 97
(46)	AmCl 19.08 + 15.085		1.522	Schiff	75
		2.324	2.327	Eder	92, 98, 76
(47)	AmBr 19.08 + 23.09				
(48)	Am.formate 19.08 + 8 + 7.53 + 4.45 + 9.95	1.285	1,271	Schroder	99
		1.68	1.628	Schiff	
(49)	Am_2SO_4 19.08 + 23.87 + 35.61		1.76	Kopp	
(49A)	$C_6H_5NH.CHO$ 74.45 + 0.83 + 5.76 + 8 + 7.53 + 9.95	1.14	1.14	17° Nostrand	
(50)	$C_6H_5NH.CH_2C_6H_5$ 2(74.45) + 0.83 + 5.76 + 16.42	1.06	1.065	25° Nostrand	
(51)	Pyrrol C_4H_4NH 4(0.71) + 3(15.25)				

+ 12.22 + 0.83 + 5.76	0.994	0.975 1.077	12.5° Wiedel Anderson	133
(52) $Et_2N.C_6H_5$ 12.22 + 5.76 + 4(16.42) + 0.83 + 74.45	0.9875	0.9851	20° Nostrand	
53) $CHO.N.C_5H_{10}$ 8 + 9.95 + 7.53 + 0.83 + 5(16.42)	1.04	1.0235	25° Kahlbaum *i.e.*, 1.03 15°	
(54) $N_3P_3Cl_6$ 3(0.83 + 10.51) + 6(23.01)	2.02	1.98	Nostrand	
(55) Piperidine 15.25 + 0.83 + 5(16.42)	0.866	0.866	15° Perkin	63, 69 110, 93
(56) β-Methylpiperidine 15.25 + 0.83 + 6(16.42)	0.865	0.8686	4° Hesekiel	112
(57) α-Methylpiperidine 15.25 + 0.83 + 6(16.42) + 2.27	0.848	0.860	0° Ladenburg *i.e.*, 0.848 15°	111
(58) α-Propylpiperidine 15.25 + 0.83 + 8(16.42) + 2.27	0.849	0.846 0.863	12.5° Petit 0° Ladenburg	114
(58A) $C_3H_7NH_2$ 58.29 + 16.54	0.762	0.7688	Perkin	117

TABLE XXX.

Heat of Combustion of Nitrogen, 20500 (gas, 18° C.).

		Theor.	Obs.	Corresponds with
(59) CH_3NH_2 27853 + 157787 + 20500 + + 27194 + 26375	=	259709	258320	1, 65
(60) $C_2H_5NH_2$ 27100 + 2(157787) + 20500 + 27194 + 26375	=	416743	415670	2, 101, 66
(61) $C_3H_7NH_2$ 27100 + 3(157787) + 20500 + 27194 + 26375	=	574530	575740	3, 100, 107, 67
(62) Amylamine 27100 + 5(157787) + 659 + 20500 + 27194 + 26375	=	890763	890580	6a, 68, 108
(63) Piperidine 27100 + 20500 + 5(157787)	=	836535	833790	55, 110, 93, 69
(64) Allyl thiocarbamide, C_3H_5NCS 463025 + 20500 + 104218 + 86429	=	674172	675360	70

where 463025 = 223844 + 2(27100) + 27194 + 157787

TABLE XXXI.

Heat of Formation of Nitrogen, − 20500 (gas, 18° C.).

		Calculated by Collins	Calculated by Thomsen	Corresponds with
(65) $C.H_3.N.H_2$ 6527 + 7391 − 20500 + 7186 + 8005	=	8609	9542	1, 59
also 5(3480) + 96418 − 259709	=	8609	8380	
(66) $C_2.H_5.N.H_2$ 7280 + 2(7391) − 20500 + 7186 + 8005	=	16753	17510	60,
also 7(34380) + 2(96418) − 416743	=	16753	15770	2, 101
(67) $C_3.H_7.N.H_2$ 7280 + 3(7391) − 20500 + 7186 + 8005	=	24144	22760	3, 100
also 9(34380) − 3(96418) − 574530	=	24144	20420	107, 61
(68) Amylamine 7280 + 5(7391) − 659 − 20500 + 7186 + 8005	=	38267	38560	6a, 108
also 13(34380) + 5(96418) − 890763	=	38267	35080	62
(69) Piperidine 7280 − 20500 + 5(7391)	=	23735	24090	55, 110
also 11(34380) + 5(96418) − 836535	=	23735	26990	93, 63
(70) C_3H_5NCS − 31008 + 2(7280) + 7186 + 7391 − 20500 − 7800 − 15530	=	−45701	−45540 −46700	64
also 4(96418) + 5(34380) + 70899 −				

TABLE XXXII.

Heat of Formation of Nitrogen − 23630 (aqueous).

			Theor.	Obs.	Corresponds with
(71)	Am.O.H. 8390 + 96155 − 15300	=	89245	90000 88800	
	where 8390 = − 23630 + 4 × 8005				
(72)	$N.H_5.C.O_3$ 8390 − 15300 + 210796	=	203886	202300	86, 82
	where 210796 = − 13855 + 32341 + 2(96155)				
(73)	$N_2.H_8.S.O_4$ 2(8390) + 26320	=	279989	281100	83
	where 263209 = 6217 + 2(32341 + 96155)				
(74)	$N.H_5.S.O_4$ 8390 − 24350 + 263209	=	247249	245100	89, 84
(75)	$N.H_4.Cl$ 8390 + 63870	=	72260	72800 73712	
(76)	$N.H_4.Br$ 8390 + 52930	=	61320	60970	
(77)	$N.H_4.I$ 8390 + 37720	=	46110	45750	38, 94 89
(78)	$Am_2.H.P.O_4$ 2(8390) − 15300 − 8593 + 117460 + 2(96155) + 71515	=	374172	375000	42
(79)	$Am.H_2.P.O_4$ 8390 − 15300 − 24350 − 8593 + 71515 + 2(96155) + 117460	=	341432	321200	40
(80)	$N_2.H_8.S_2.O_8$ 2(8390) + 6217 + 0 + 96155 + 71515 + 6(32341)	=	384713	383200	87
(81)	$N_2.H_8.S.O_3$ 2(8390) + 0 + 96155 + 71515 + 32341	=	210791	213960	88

TABLE XXXIII.

Heat of Formation of Nitrogen, − 20500 (solid).

			Theor.	Obs.	Corresponds with
(82)	$N.H_5.C.O_3$ 11520 − 15300 + 210796	=	207016	208600	36, 72
	where 11520 = −20500 + 4(8005)				
(83)	$N_2.H_8.S.O_4$ 2(11520) + 0 + 256992	=	280032	283500	73
	where 256992 = 2(32341 + 96155)				
(84)	$N.H_5.S.O_4$ 11520 − 24350 + 0 + 256992	=	244162	244600	39, 74
(85)	$N.H_4.S.H$ 11520 + 49959 − 24350	=	37129	37060	
(86)	$Am_2.H.P.O_4$ 2(11520) − 15300 + 8593 + 71515 + 3(96155)	=	376313	375000	35
(87)	$N_2.H_8.S_2.O_8$ 2(11520) + 6217 + 0 + 96155 + 71515 + 6(32341)	=	390973	392900	80
(88)	$N_2.H_8.S.O_3$ 2(11520) − 6217 + 96155 + 71515 + 32341	=	216834	215500	81
(89)	$N.H_4.I$ 11520 + 36226	=	47746	49800	38, 77, 94
(90)	$N_2.H_8.C_2.O_4$ 2(11520) − 2(32078) + 96155 + 3(71515)	=	269584	270100	43
(91)	$N.H_4.Cl$ 19610 + 56786	=	76396	76800	46, 97
(92)	$N.H_4.Br$ 19610 + 45244	=	64854	65350	47, 76, 98
	where 19610 = −20500 + 3(8005) + 16095				

TABLE XXXIV.

Magnetic Rotation of Nitrogen, 0.49

			Theor.	Obs.	Corresponds with
(93)	Piperidine 0.235 + 0.49 + 5(1.023)	=	5.840	5.803 5.821	55, 110 63, 69
(94)	NH_4I 0.49 + 4(0.399) + 17.83	=	19.916	19.936 20.049	38, 77, 89

(95)	Am.propionate 0.49 + 4(0.399) +				
	0.683 + 0.042 + 0.202 + 2(1.023) +				
	0.285	=	5.244	5.255	
				5.263	
(96)	Dipropylamine 0.235 + 0.265 +			7.558	
	6(1.023) + 0.399 + 0.49	=	7.527	7.512	
(97)	NH_4Cl 0.49 + 3(0.899) + 0.5175 +				
	3.982	=	6.1365	6.096	46, 91
(98)	NH_4Br 0.49 + 3(0.899) + 0.5175 +				
	7.95	=	10.1545	10.159	
				10.196	47, 92, 76
(99)	Am.formate 0.49 + 3(0.899) +				
	0.1575 + 0.683 + 0.042 + 0.315 +			3.394	
	0.165	=	3.3595	3.333	48
(100)	$C_3H_7NH_2$ 0.235 + 3(1.023) + 0.49				
	+ 0.399 + 0.399	=	4.592	4.540	3, 61, 67
				4.597	107
(101)	$C_2H_5NH_2$ 0.235 + 2(1.023) + 0.49				
	+ 0.399 + 0.399	=	3.569	3.585	
				3.631	2, 60, 66
(101A)	$NH_2.(CH_2)_5.NH_2$ 0.399 + 0.165 +				
	+ 0.49 + 5(1,023) + 0.49 + 0.399				
...	+ 0.399	=	7.457	7.473	
				7.519	12, 106
(102)	Benzylamine 11.327 + 1.023 + 0.49				
	+ 0.399 + 0.399	=	13.638	13.646	18
(103)	$EtNH_2.HCl$ 0.235 + 2(1.023) + 0.49				
	+ 3(0399) + 3.923	=	7.891	7.997	
(104)	$Et_2NH.HCl$ same + 2(1.023)	=	9.987	9.896	

TABLE XXXV.

Optical Refractivity of Nitrogen, 2.493.

(105)	$NH_2.(CH_2)_2.NH_2$ 2(2.493 + 1.125 +					
	0.82) + 2(4.6135)	=	18.103	18.12	Bruhl	11 11a
(106)	$NH_2.(CH_2)_5.NH_2$ 2(2.493 + 1.125					
	+ 0.82) + 5(4.6135)	=	31.9435	31.91		12, 101a
(107)	$C_3H_7NH_2$ 0.985 + 3(4.6135) + 2.493					
	+ 1.125 + 0.82	=	19.2635	19.33		61. 67
(108)	Amylamine 0.985 + 5(4.6135) +					
	2.493 + 1.125 + 0.82	=	28.49	28.53		6, 6a, 62, 68
(109)	Octylamine 0.985 + 8(4.6135) +					
	2.493 + 1.125 +0.82	=	42.331	42.41		9
(110)	Piperidine 0.985 + 2.493 + 5(4.6135)	=	26.5455	26.52		55, 93, 63, 69
(111)	α-Methylpiperidine 0.985 + 2.493 +					
	6(4.6135)	=	31.159	31.16		57
(112)	β-Methylpiperidine same	=	31.159	31.12		56
(113)	Pyrrol C_4H_4NH 2(6.666) + 3(0.985)					
	1.125 + 2.493 + 0.82	=	20.725	20.75		51
(114)	α-Propylpiperidine 31.159 +					
	2(4.6135)	=	40.386	40.31		58
(115)	α-Isob. piperidine 40.386 + 4.6135	=	44.9995	44.76		
(116)	$HCO.NH_2$ 1.125 + 3.333 + 1.747 +					
	2.493 + 1.125 + 0.82	=	10.643	10.56		24
(117)	$C_3H_5NH_2$ 14.3745 + 2.493 + 1.125					
	+ 0.82	=	18.8125	18.81		58a

In Nos. 100 to 104 one of the H-atoms has been altered by the magnetic field from 0.165 to 0.399, *i.e.*, its relative volume has decreased from 9.95 to 5.76. Other instances of this were given in Paper II on Nitrogen. Nos. 92. 94 and 95.

INTERNATIONAL INSTITUTE OF AGRICULTURE.

THE WORK OF THE PERMANENT COMMISSION OF AGRICULTURAL ASSOCIATIONS.

The Permanent Commission of Agricultural Associations in its first plenary session at the International Institute of Agriculture, and numbering 70 delegates, proceeded to the following nominations :

Honorary Presidents—Marquis de Vogüé, President of the Société des Agriculteurs de France, and Mlle. Matthei, of the International Labour Office. President—M. Posthuma, ex-Minister of Agriculture, delegate of the Algemeene Nederlandsche Zuivelbond, of the Hague. Vice-Presidents—M. Robinson (Great Britain), Brandes (Germany), Torres Filho (Brazil), Ayara (Spain), Gautier (France), Pikstone (South Africa), and as general reporter, M. Thaon de Revel (Italy).

The President of the Institute, Prof. De Michelis, explained the task of the Commission and the President of the Assembly. M. Posthuma followed with a brief speech. The subsequent discussion was of a general character, and was in the direction of defining the task the International Institute of Agriculture is called upon to perform in the agricultural world by means of the Permanent Commission of Agricultural Associations. It was concluded that the Institute in its quality of inter-State organisation has a special obligation, with respect to the various Governments, to support and defend the interests of Agriculturists seeing that the Economic Conference lately held at Geneva, recognised the agriculture has equally with industry and trade, its importance in world prosperity.

The subject of the periodical publications by the information service of the International Iustitute of Agriculture was also dilated; the Institute, it was unanimously decided, should be the international centre for diffusion and discussion of all information of an agricultural character. The Commission then adjourned.

The Scientific Council convened at Rome by the International Institute of Agriculture continued its technical work; a large number of experts divided into 24 Commissions studied various scientific problems dealing with agriculture.

An important discussion took place at the Commission dealing with Rural Economy. M. Thompson, the President, dealt with the co-ordination of the results obtained by the Agricultural Accountancy Bureaux in the various countries. After a statement by the reporter, M. Brdlik, the discussion centred around the questionnaire drawn out by the Institute with the object of essembling in all the countries the necessary data according to a uniform plan making possible the establishment of international statistics with respect to agricultural accountancy. Among the speakers were Prof. Brdlik (Czechoslovakia), Prof. Mess (Holland), M. Angé Laribe and Prof. Deloss (Belgium). Prof. Laur (Switzerland) dealt in particular with the questionnaire. A small committee composed of Prof. Brdlik, Prof. Laur, Prof. Ostermayer and Prof. Tassilari (Italy) was appointed to co-ordinate the elements of the discussion.

The Commission for the Improvement of Rural Life, under the presidency of M. Graffitau (Belgium), discussed problems arising out of hygienic dwellings, and general and technical instruction of rural families. The Commission passed an unanimous resolution that these problems should form the subject of an inquiry in order to obtain a better standard of conditions in the country as compared with those prevailing in towns.

A special discussion presided over by Prof. Derlitgki dealt with the scientific organisation of labour in the sphere of agriculture. The lucid contributions of M. Mauro (Italy), Prof. Seedorf (Switzerland), and Prof. Bopckaert (Belgium) de Wuyst (Belgium), M. Devinat (Geneva) and of the President, made it possible to trace out the fundamental lines of the policy of the Institute in this direction.

FORESTRY AND SOIL SCIENCE.

The Forestry Commission emphasised the importanee of fruit trees, especially in countries with dry climates where it would be advisable to extend the use of fumigation now neglected. The question of frigorific chambers for the preservation of fruit was also considered. The Sylviculture Commission, presided over by Prof. Cotta, dealt with damage caused by wind and forest.

The Plant Disease Commission presided over by M. Mangin (France) initiated an examination of an international phytopathological convention. Interesting communications were made in the Soil Science Commission. Statements were made by the delegates for Italy, Holland, Austria and Luxemburg. The utilisation of plant and soil poducts wras also the subject of impor-

tant discussions by the Commissions for the Agricultural Industry in Plant Products.

The Commission for Agricultural Meteorology emphasised the fact that meteorological statements published should be in greater detail. M. Chaptal (France) presented certain proposals on this subject.

ANIMAL HUSBANDRY.

Under the presidency of the French ex-Minister of Agriculture, M. Massé, the Animal Husbandry Commission dealt with zootechnical experimentation and the orientation to be given to methods of reproduction for the protection of native breeds. The Commission noted two important resolutions consisting in pursuing the improvement and unification of methods of work with respect to a certain number of points with respect to which it is possible to defend native breeds according to a determined method of selection.

The second session of the International Scientific Council was opened by his Excellency De Michelis, President of the Institute, who spoke about the work of the Commissions. The Presidential Bureau was completed by the following Vice-Presidents: M. Brizi (Italy), Trksson (Sweden), Laur (Switzerland), Russell (Great Britain.) The discussion continued on the proposal of Prof. De Michelis, with respect to the possibility of an international understanding for uniformity of evaluation of certain products which form the snbject of international exchange. The resolution, which was approved, emphasises the importance of the subject which has been referred to the Permanent Committee of the Institute and the International Scientific Council. The Council then proceeded to deal with the question of the new orientation it is possible to give to agriculture in the various countries as the result of recent scientific discoveries and of the general economic situation arising out of the European conflict.

The General Secretary of the International Institute of Agriculture, Prof. Dragoni (Italy), summarised an interesting proposal on this snbject. The Vice-President of the Institute, M. Louis-Dop (France), referred to the important political and scientific task incumbent on the International Institute of Agriculture. Other speakers, M. Odén (Switzerland), M. Wagener (Germany), and Sidquest (Germany), referred to various aspects of the problem, Agriculture, which has declined since the war. On the farmer rests the prosperity of every country; rural life must be ennobled. Mr. Russell (Great Britain) referred to the necessity of organising transports in tropical countries; M. Menozzi (Italy) dealt with the necessity of improving nutrition of plants; M. Bruno (Italy) with the use of fumigation Prof. Dragoni, general secretary of the Institute, passed in review certain points with respect to the welfare of farmers and especially the facilities for agricultural credit. M. Louis-Dop closed the discussion with a notice of motion.

ADDRESS ON THE CHEMICAL INDUSTRY.

By THE RIGHT HON. SIR ALFRED MOND, Bart., M.P. (Chairman : Imperial Chemical Industries, Ltd.)

(Read by Dr. F. A. Freeth, F.R.S., at the Central Economic League, Caxton Hall, Westminster, Thursday, 20 October, 1927.)

The place of the chemical industry in the industrial and commercial economy of the world, and perhaps no less in its political economy, must always increase in importance. For industry is becoming always more interdependent and many of the basic industries of this countries have to rely more and more upon the Chemical Industry for essential raw materials. Consider for example those growing and prosperous industries which, if recent in expansion, are showing a most youthful vigour and development. the artificial silk industry. the wireless industry, the motor car industry, the electrical industry and many others.

In speaking generally of the chemical industry perhaps the main points on which you will desire to hear something are :—

Firstly, The organisation of the industry on its commercial and economic sides, and

Secondly, the products and processes employed in the industry, their history, development and application, and

Thirdly, what is of extreme importance at the present time, when almost the whole world realises the importance of industrial peace, the history of relationship between all those employed in the Chemical Industry over the last fifty years, and the first instalment of the Labour programme which has just been announced in Imperial Chemical Industries, Ltd.

The chemical industry plays such an important and predominant part in all industrial developments that the two statements "Chemicals form the foundation of the

world's industries," and "The chemical industry is essential to Imperial security," require elaboration rather than justification. The extraordinary amenities and comforts of modern life are so much taken for granted that everyone does not realise the great debt which we all owe to the development of modern industry and the chemical industry in particular.

It has been stated that the standard of comfort enjoyed by the average working man of to-day is greater than that of a wealthy and powerful nobleman of the Middle Ages. Such a state of affairs may well be called a miracle, and it is largely due to the modern industrial system, in which chemicals play such an important part. If we analyse the ordinary doings of the ordinary man throughout the twenty-four hours, we find that all the objects with which he deals and most of the food he eats have come at some time or other within the province of chemical industry. Before, however, giving any account to you of the past or the probable future of the chemical industry, I should like to describe to you the state in which it is to-day in this

Our company can fairly claim to be representative of the industry as a whole, on a majority or any other basis. The volume of our production is enormous, in some of our industries such as the Alkali trade we always discuss our outputs in the terms of hundreds of tons per day. And in those industries such as dyemaking, where the tonnages are naturally not so heavy, the output, in its class, is very high indeed. The list of our products if I were to read it to you would take hours. Our four main constituent companies, whom as you will remember, are Brunner, Mond & Co., Ltd.; Nobel Industries, Ltd.; British Dyes; and the United Alkali Co., Ltd.; have a total of seventy-five constituent and associated companies.

Our total production amounts to millions of tons per annum, worth scores of millions of pounds in value, our dyes and intermediates total over five thousand alone, and we make other chemicals and explosives in every imaginable variety. Our consumption of raw materials is enormous, the amount of coal we burn, though you may be assured that every device is employed to do this as economically as possible, runs into hundreds of thousands of tons per annum. Again, we quarry millions of tons of limestone every year.

We employ about 40,000 men, among whom the importance of a small army of chemists and engineers must not be forgotten. We ransack the Universities for talent and have even been accused of unduly depleting them! Our works are distributed throughout the country and range from Land's End to the Forth and from the Forelands to the Clyde.

The alkali trade can fairly claim to be dealing with the raw material of raw materials. The reason that, generally speaking, the public are unaware of its extent and importance is that ts products have often been used and its work is frequently done before there is any general interest in the substances produced. Take, for example, the preliminary treatment of cotton, the purification of boiler water, the early stages of paper-making—all these operations use alkali in some form or other in the very early stages of production.

Nearly everything, when you go back to it, comes out of the ground. In the alkali trade we begn with common salt, a material of wheih this country possesses abundance. The largest deposits are situated in Cheshire, which is the centre of the heavy alkali trade. The extent and size of the works engaged in alkali manufacture would surprise many people. The principal product made is soda ash, which is the trade name for sodium carbonate. Salt brine is pumped up from the earth and put through an elaborate and continuous series of processes which are mechanised to a very high degree indeed. There are few more impressive sights than the interior of one of these great factories at night; a steady hum of machinery, an astonishingly small number of men, with an output running into hundreds of tons per day from each unit. The alkali industry is also connected with the production of chlorine, the well-known bleaching agent.

There is a very close connection in the chemical industry between the processes which can make a country prosperous in peace and efficient in war. Consider fertilisers and explosives. The same compound which deals death and destruction can also be a valuable plant food, because in each case it contains that essential body, fixed nitrogen. The explosive industry of course is not as might be supposed maintained on a basis of preparation for war. The use of explosives in the ordinary arts of peace, coal minng, quarrying, etc., is very great indeed, and our huge explosive works in Scotland and many other places in the country are among our greatest assets.

The fertiliser industry is as far as we are concerned a comparatively new one. We have recently erected at Billngham, in the county of Durham, a factory for the extraction and fixation of the nitrogen of the air. This business, as will be shown later, is intimately linked with the future of agriculture in this country. The initiation of this industry has been a brilliant feat of engineering, and one which maintains the traditional hgh standard of that science in Great Britain. In the past the chemist has probably claimed and received rather more than his share of credit for the success of our industry, which frequently offers greater difficulties to the engineer who puts into practice than to the chemist who originally worked it out in the laboratory.

Good engineering can turn an unprofitable chemical process into a profitable one notwithstanding that the same chemical reaction has been used under comparable conditions in each case.

GENERAL NOTES.

PURE AIR CAMPAIGN.

With a view to making effective the new law dealing with the abatement of atmospheric pollution, a special four weeks' course of instruction is to be given to smoke inspectors employed by local authorities throughout the kingdom, and to all others interested.

The lectures, which have been arranged by the Royal Sanitary Institute, were given at the Institute's lecture hall in Buckingham Palace Road, and the first of the series took place on Friday, November 4. Some of the greatest experts in the country have been engaged for the purpose. Among them are Dr. J. G. King, who ably dealt with the purely chemical side of the problem; Mr. R. J. Sarjant, M.Sc., who explained the construction of furnaces and chimneys; and Mr. E. W. L. Nicol, who lectured on the principles and practices of stoking.

Mr. Laurence Chubb, the secretary of the Coal Smoke Abatement Society, fully explained the provisions and penalties of the new Smoke Abatement Act, and Dr. J. S. Owens, Secretary to the Advisory Committee on Atmospheric Pollution to the Air Ministry, will deal with various technical phases of the question. Among other things, he will speak on smoke prevention as it is affected by domestic fires, and will treat in outline the application of gas and other smokeless agents for the production of heat.

There will be opportunities for the officials undertaking the course to attend a number of inspections and demonstrations at various works and institutions to study smoke prevention methods.

BOARD OF TRADE ANNOUNCEMENT.

Dyestuffs (Import Regulation) Act, 1920.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during October has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 846, of which 690 were from merchants or importers. To these should be added 11 cases outstanding on September 30, making a total for the month of 857. These were dealt with as follows :—

Granted—738 (of which 69 3were death with within 7 days of receipt).

Referred to British Makers of similar products—86 (of which 64 were dealt with within 7 days of receipt).

Outstanding on October 31, 1927—33.

Of the total of 857 applications received, 757, or 85 per cent. were dealt with within 7 days of reeeipt.

BIG DEAL IN ONTARIO TOBACCO LANDS.

In the largest transaction in Western Ontario farm lands consummated in many years, the Norfolk Tobacco Plantations, Ltd., has acquired 1,800 acres in Norfolk County for flue-cured tobacco growing. It will require $5,000,000 to pay for the lands, together with the buildings and equipment which the purchasers propose to place on the property this year.

Tobacco handling and packing plants have beeu established rapidly in Western Ontario ad one recently erected at Chatham has a capacity of ten to fifteen million pounds of leaf annually. Plants now in operation in the district are capable of handing from 60,000,000 to 75,000,000 pounds of tobacco each season. The capital behind these plants has largely come from Great Britain.

CANADA'S TRADE HIGHER BY $12,000,000 IN SEPTEMBER.

The grand total of Canadian trade for the month of September increased by more than $12,000,000 over the corresponding month last year. Both imports and exports show considerable gains. The total for the month was $191,137,407, as compared with $178,889,595 for September 1926. Of the 1927 figure the value of goods exported from Canada exceeded imports by $5,609,539, the relative figures being: Exports, $97,412,316; Imports, $91,802,777.

CANADA CEMENT COMPANY SOLD FOR $46,875,000.

In one of the largest financial transactions ever to take place in Canada, the shareholders of *Canada Cement Company* at a special general meeting at Montreal approved the sale of the Company's assets to Messrs. Wood, Gundy and Company, Limited.

The shareholders will receive $250 for each share. The Canada Cement business passes into the hands of the purchasers for a total of $46,875,000. A public offering of securities in the new company will be made shortly.

GERMANY—COAL BY-PRODUCTS.

The acting British Consul-General at Cologne informs the Department of Overseas Trade that the "*Deutsche Bergwerks Zeitung*" of 4, November states that the demand for raw tar is quite good altogether lower prices are being offered and paid, in accordance with the general position of the tar market, which is showing a downward tendency. There is no doubt that the demand and sales in pitch are declining, partly owing to the fact that road-making has ceased, and especially owing to the decline in the manufacture of briquettes. Not only in Germany but in all countries where coal is exploited and briquettes are produced complaints are made about the shortage in briquettes sales. This is probably due in part to the price of briquettes but also because a large proportion of fine coal is used for dust firing which has been increasingly employed since the beginning of the year. The consumption of pitch has greatly increased.

As a result of this prices of pit coal pitch have fallen and prices for pit coal tar oil are also showing a downward tendency in spite of a brisk demand.

GERMANY.

STAHLWERKSVERBAND REPORT FOR OCTOBER.

The Acting British Consul-General at Cologne has forwarded to the Department of Overseas Trade the following report of the Stahlwerksverband for October, as published in the *Deutsche Bergwerks Zeitung* of 8 November.

Products Association.—The receipt of orders for semi-products for home consumption have remained on very much the same level as last year. Export trade has somewhat improved but prices are still unsatisfactory.

Home trade in sections has fallen off in accordance with the season. Calls on old contracts were, however, satisfactory. Export trade was stagnant and prices low.

In heavy permanent way material, calls on former contracts have decreased. It may, therefore, be assumed that the monthly deliveries will also be less.

Bar Iron Association.—The market position at home has not changed during the month of October. Sales and the fufilment of old orders are proceeding as usual. The monthly exports have been disposed of readily. The prices realised were, on an average, somewhat better than last month. The receipt of specifications continues good.

Hoop Iron Association.—In the home market a decline of orders is reported from certain districts, while other districts report good business. The total result will, therefore, be an improvement over last month. Abroad, the autumn business has set in and, as far as quantity is concerned, there is certainly an improvement, but prices are still very depressed.

Thick Plate Association.—The receipt of specifications during October was good. New orders were booked to the same extent as during the preceding month. Prices have remained unchanged.

WHOLESALE PRICES IN OCTOBER.

An average decline of 0.5 per cent. in wholesale prices is shown for October as compared with the preceding month, the inde xunmber being returned at 85.1 as against 85.5. The figure a year ago was 91.5.

DISTRIBUTION OF OVERSEAS TRADE.

In the course of a review of the distribution of the trade of the United Kingdom among the countries of the world during the first nine months of the present year, it is shown that imports from Empire sources amounted to 26.70 per cent. of the whole, as against 30.11 per cent. in the corresponding period of 1925, while exports of British produce to Empire destinations reached 42.76 per cent. of the total, as against 39.16 per cent.

BRITAIN'S GREATEST FAIR.

Some idea of the wide range of goods that will be on view at the next British Industries Fair may be gathered from the forecast provided of the Leather and Leather Goods and other sections. Meantime 1,700 British manufacturers have booked space at the Fair.

SWISS TRADE IN SEPTEMBER.

As compared with August imports and exports advanced by 5.6 million francs and 8.2 million frs. respectively. Although the trade balance remains unfavourable it showed a slight improvement, exports representing 82.8 per cent. of imports, as against 81.2 per cent. iu August and 80.5 per cent. in July.

BELGIAN BEET SUGAR.

The Department of Overseas Trade has received from the Office of the British Commercial Secretary at Brussels a report from *L'Indépendance Belge*, which states that the Confédération Générale des Planteurs de Betteraves has passed certain resolutions which have been submitted to the Minister of Agriculture.

Among the suggestions the Federation wish to have adopted are the following :—

1. Increase of Customs duties on sugar to 100 francs per metric quintal.

2. Reduction of consumption duties from 125 francs to 65 francs.

3. Elaboration of an agreement between sugar beet planters and manufacturers for the export of excess sugar production.

KOREAN SALT PRODUCTION.

The Acting British Consul-General at Seoul reports that the total amount of salt produced in Korea by evaporation during the first nine months of the current year was 214,528,313 lbs., an increase of 13,954,485 lbs. over the corresponding period of 1926.

SYNTHETIC RUBBER.

It is reported that after extensive experiments, the great German dye company, I. G. Farbenindustrie, has invented a practical process for the manufacture of synthetic rubber at competitive prices.

ROYAL SOCIETY OF ARTS.

Report on the Society's Examinations, 1927.

Considerable developments in connection with the Society's Examination system have taken place during the last year. In addition to the three series of Evening Commercial examinations which are now held regularly at Easter, Whitsuntide and in July, two further sets of examinations were instituted this summer. The first of these was an examination for certificates of two grades, known as the School and Junior School Certificates, and the second, undertaken at the request of the London Couuty Council, were Group Course Examinations for students at L.C.C. Junior Commercial and Junior Technical Institutions. A brief report on these new examinations will be found on pages 1220 and 1223. Meantime, it may be mentioned that as a result of them the total number of papers worked this year is agaiu a record, the figure being 88,088, as compared with 88,246 in 1926. Of these 78,142 were worked at the Evening Examiuations. This figure shows a decrease of 5,104, as compared with the total for 1926. The reduced number is due to the discontinuance of the examinations in Commercial Correspondence (for which there were 3,909 entries last year) and to the fact that a large number of candidates from the L.C.C. Commercial Institutes, who in previous years took the ordinary evening examinations, in 1927, took the new Group Course Examinations specially provided for them.

Surprise is very often expressed at the

very large numbers who take the Society's Examinations. The fact is that they meet the wants of an enormous class of students for whom no other provision is made. It is the fashion in certain quarters to belittle the value of examinations and even to condemn them utterly as educational dangers. This is, perhaps, hardly the place to fight over again the old battle of external and internal examinations; but the Council is strongly of opinion that the average student works better when he has a definite goal in view, and he has long ago found out that his chances of securing employment are greatly improved if he can produce unbiassed evidence of his capabilities, such as a certificate of the Royal Society of Arts affords. The value of this certificate is recognised more and more clearly every year by employers and is probably as well known in Aberdeen as in London.

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

At the meeting held on November 10, 1927, the following papers were read in title only :—

Commutative Ordinary Differential Operators. By J. L. BURCHNELL AND T. W. CHAUNDY. *Communicated by* A. L. Dixon, F.R.S.

The paper discusses the necessary and sufficient conditions that two differential operators

$$P = D^m + \mu_1 D_m^{-1} + \mu_m,$$
$$Q = D_n + \nu_1 D_n^{-1} + \ldots + \nu_n$$

be commutative. Associated with any polynomial $f\ (p, q)$ of a certain type is a group [P, Q] of pairs of commutative operators which also satisfy the identity f (P. Q) = 0. The construction of these operators is based on the set of Abelian equations of the first kind associated with the polynomial $f\ (p.\ q)$; the function $\eta\ (p, q)$ which is annihilated by both $P—p$, $Q—q$ is an Abelian function of the second kind.

If P′, Q′ denote the operators adjoint to P, Q, then the group of adjoint pairs [P′, Q′] can be derived from the group [P, Q] by change of sign of x, and in particular there is one pair in the group which can be derived from its adjoint in this way.

If P, Q is a commutative pair, there are operators T such that we may write

$$TP = P_1T, \qquad TQ = Q_1T,$$

where P_1, Q_1 are other operators also commutative and obeying the same identity as P, Q. We can get in this way from any other one pair of the group to any other pair. The process corresponds to residuation if $f\ (p, q) = 0$ is interpreted as a plane curve, and therefore to the process of addition in the Abelian theory.

Periodic Solutions of Hamiltonian Systems of Differential Equations. By T. M. CHERRY. Communicated by H. F. Baker, F.R.S.

The paper develops the theory of periodic solutions of a fourth order Hamiltonian system

$$\left.\begin{aligned} \frac{dx_k}{dt} = \frac{\delta F}{\delta y_k}, \quad \frac{dy_k}{dt} = -\frac{\delta F}{\delta x_k} \quad (k = 1, 2) \\ F = F(x_1, y_1, x_2, y_2) \end{aligned}\right\} (1)$$

Such equations arise in dynamical questions such as "the problem of three bodies." Periodic solutions are of interest for their own sake but their real importance lies in the fact that for no other sort of solution do our present analytical means suffice to give complete information.

It has been necessary to start the theory almost from first principles, because the existing theory (Poincaré's) is unsuited to finding the mutual relations of the periodic solutions of (1). The nature of the case is illustrated by the following analogy : It is as though we wished to explore a mountain chain and its ramifications, and Poincaré's method forces us to descend to a flanking valley after each peak, and therefore to regard the chain as a collection of peaks and not as a totality.

Any solution is regarded as periodic for which the x_k, y_k are Laurent series in an argument e , σ being a constant; the period is real if σ is pure-imaginary. The main results are :—

(1) Periodic solutions occur in general in continuous singly infinite families whose analytical specification has the form

$$x_k = f_k\ (\sigma, e^{\sigma t}),\ y_k = g_k\ (\sigma, e^{\sigma t})$$
$$\{\sigma \text{ arbitrary}\},$$

f_k, g_k are obtained as double series for which a definite domain of convergence is established.

(2) With each solution of a family is correlated a number R which may be real or unreal, and which varies continuously along the family. From any solution S for which R is real and rational there branch two (in general) new families, whose periods near S are approximately integral multiples of the

period of S. A family for which R is real thus throws off branches at all its "rational" members.

(3) These families, when real, are susceptible of a geometrical representation in which to each periodic solution corresponds a pointn, and to each family a line in 3-dimensional space. Taking the whole aggregate of such lines they apparently join up so as to form a system of closed meshes of complicated character, only partly elucidated.

THE OPTICAL SOCIETY.

Abstract of paper read and discussed at the meeting of the Society on 10 November:

On the Resolution of Gratings by the Astigmatic Eye. By J. R. HAMBLL, B.Sc., AND T. H. WINSER.

An investigation of the resolution of gratings by the human eye, commenced by H. H. Emsley in 1925 was continued. The irregular curves representing variation of grating acuity from meridian to meridian is found to be of the same general form in all astigmatic eyes. Experiments show that the images of gratings placed in various directions, which are produced by an ordinary astigmatic system, show irregularities of the same form due to the overlapping of tre blurred images of the separate lines of the gratings. Thus an eye with regular astigmatism will exhibit irregularities in resolving gratings at various inclinations, and charts consisting of fine parallel lines are not reliable for testing ocular astigmatisms.

Demonstration of "The Deviograph and Anatomical Trial Frame. By OWEN AVES.

The Deviograph is an instrument designed by the author to provide the refractionist with a means of obtaining grapric records of muscular imbalance. The instrument has the great advantage of providing a permanent record of the state of the patient in this respect. Use of the instrument ras shown that perfect Orthophoria is comparatively rare, and that regular lateral deviations are most common. Practical demonstration of the instrument and the method of using it were given.

The Anatomical Trial Frame was exhibited.

FORTHCOMING EVENTS.

CHEMICAL SOCIETY.

Burlington House, London, W.1.
Thursday, December 1.

GEOLOGICAL SOCIETY.

Burlington House.

Wednesday, November 30, at 5.30 p.m.—"The Granites of the Scilly Isles, and their Relation to the Dartmoor Granites." By Charles William Osman, M.Inst.C.E., F.G.S. To be read by Sir John Flett.

INSTITUTE OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, London.

Thursday, December 1, at 6 p.m.—R. B. Matthews: "Electric Ploughings." (Illustrated.)

Mersey and North Wales Section.

Wednesday, November 30. — Annual Dinner at the University Club.

N.E. Section. Armstrong College, Newcastle-on-Tyne.

Monday, November 28, at 7 p.m.—B. S. Cohen: "Apparatus Standards of Telephonic Transmission."

North-Midland Section, Hotel Metropole, Leeds.

Tuesday, November 29, at 7.15 p.m.—F. V. Levett: "Oil Electric Automatic Control of a Hydro Extractor."

North-Western Centre, 17, Albert Square, Manchester.

Tuesday, November 29, at 7 p.m.—"Higher Steam Pressures," by A. H. Law and J. P. Chittenden.

INSTITUTE OF METALS.

Birmingham Section.
Engineers' Club, Waterloo Street.

Tuesday, November 29, at 7 p.m.—Dr. G. B. Bengough, M.A., D.Sc.: "Corrosion."

Saturday, December 3.—Annual Dinner, at Queen's Hotel.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

36, George Street, Manchester.
Tuesday, November 29, at 5.30 p.m.

OIL & COLOURMEN'S ASSOCIATION.

Manchester Section.—Saturday, December 3.—Annual Dinner.

ROYAL INSTITUTE OF PUBLIC HEALTH.

37, Russell Square, London.

Wednesday, November 30, at 4 p.m.—"The Prevention of Cancer." (Illustrated.) By Prof. Blair Bell, B.S., M.D.

ROYAL INSTITUTION.

21, Albemarle Street, London.

Tuesday, November 29, at 5.15 p.m.—Sir William Bragg: "A Year's Work in X-ray Crystal Analysis."

Tuesday, December 1, at 5.15 p.m.—Dr. R. E. M. Wheeler: "London Before the Norman Conquest."

Saturday, December 3, at 3 p.m.—M. Gustave Holst: "Samuel Wesley and Robert Pearsall."

ROYAL SOCIETY OF ARTS.

John Street, Adelphi, London.

Wednesday, November 30—Professor Henry E. Armstrong, LL.D., Ph.D., F.R.S.: "Marcellin Berthelot and Synthetic Chemistry." His Excellency the French Ambassador will preside.

Dominions and Colonies Section.

Monday, November 28.—H. E. The Marquis de Merry del Val, G.C.V.O., LL.D., *will deliver a short explanatory lecture on a film showing the visit of* T.M. the King and Queen of Spain to the Djebala and Rif Country of Morrocco.

Cantor Lectures.—Monday, November 28, at 8 p.m.—Professor H. C. H. Carpenter, M.A., A.R.S.M., F.R.S.: "Alloy Steels, their Manufacture, Properties, and Uses." (Fourth Lecture.)

SOCIETY OF CHEMICAL INDUSTRY.

Manchester Section. Milton Hall, Deansgate.

Friday, December 2, at 7.30 p.m.—"Coal and Co-partnership," by J. A. Bowie, M.A., D.Litt.

UNIVERSITY COLLEGE.

Gower Street, London.

Wednesday, November 30, at 3 p.m.—Barlow Lectures on Dante: "La Lirica del *Paradiso*." First of a course of eight public lectures in Italian by Dr. C. Pellizzi. November 30 and December 7, and continued in the Second Term.

NOTICES OF BOOKS.

The Higher Coal Tar Hydrocarbons. By Arthur Ernest Everest, DSc., Ph.D., F.I.C. Pp. XIV + 334. Price 18s. net. London: Longmans, Green and Co., Ltd., 39, Paternoster Row.

Coal tar is not remarkable for its brilliancy, and has many unpleasant qualities, as many operators and experimenters have had reason to know, but how useful and what commercial possibilities lie hidden in its black, sticky mass. The compounds found in coal tar are too numerous and important to render it possible to deal with them in any simple book. Even the present work, exhaustive and useful as it unquestionably is, is confined to the higher coal-tar hydrocarbons, which have been lightly passed over in most previous works on coal-tar. The author purposely excludes naphthalene and anthracene, because they have been dealt with by other authors. From this fact it will be inferred that he has scrupulously refrained from devoting space to subjects that have been written about by other writers. The author has succeeded in including in a volume of manageable size virtually all the important facts about the higher hydrocarbons. He has given the scientific public a well-written and useful work, which deserves a large reading public.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

29,642.—I. G. Farbenindustrie Akt.-Ges.—Treating liquids with gases, etc. November 5th.

29,288.—Soc. Industrielle de la Cellulose.—*Treatment of cellulose-containing materials with mineral acids.* November 2nd.

29,440.—Kunstharzfabrik Dr. F. Pollack Ges.—Manufacture of phenol formaldehyde condensation products. November 3rd.

29,526.—Lush, E. J.—Hydrogenation of naphthalene. November 4th.

Specifications Published.

279,530.—I. G. Farbenindustrie Akt.-Ges.—*Manufacture and production of hydrocyanic acid.*

279,613.—Pickering, J.—Treatment of acid sludge or acid resin obtained from the refining of mineral oils.

260,604.—I. G. Farbenindustrie Akt.-Ges.—Manufacture of alkylnaphthalenes.

Abstract Published.

277,619.—Recovering sudpluric acid from waste acid.—Still, C., (trading as Still, C. (Firm of)), 4, Bismarckplatz, Recklinghausen, Germany.

Ammonium Sulphate; benzol; pitch and tar; materials for making coke.—Acid-tar, obtained in purifying benzols by treatment with concentrated sulphuric acid, is heated with a concentrated solution of ammonium sulphate. Residual benzol hydrocarbons are vaporised and resins separate out as a floating fused mass which on cooling hardens into a cake which can be removed. The ammonium sulphate liquor containing the recovered sulphuric acid is used in an ammonia saturator to produce ammonium suphatle. The resins form a pitch-like mass which after being washed with water may be mixed with coal tar to increase the pitch content, or may be distilled with coal in a coke oven.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

ALULAK.

481,707.—All goods in class 1, which includes acids, potash, salts, and other chemical substances used in manufactures.—Reckitt and Sons, Limited, Kingston Starch Works, Dansom Lane, Hull, Yorkshire. November 9th.

VINNAPAS.

484,596.—All goods in class 1 which includes acids, potash, salts, and other chemical substances used in manufactures. — Consortium fur Elektrochemische Industrie Gesellschaft mit beschrankter Haftung, 20, Zielstattstrasse, Munich, Germany, November 9th.

GERMAN CONVERSATION
AND LESSONS GIVEN.

Translations Undertaken.

Write, S. G., c/o *Chemical News*,
Merton House Salisbury Square,
London, E.C.4.

GENERAL INDEX TO THE
"CHEMICAL NEWS"—VOLS. 1 TO 100.

This large volume contains a detailed Index to the first 100 volumes of the *Chemical News*, and will be found of great value to all interested in Chemical, Engineering, Electrical and General Scientific subjects. It has been compiled with great care, is handsomely bound in red cloth, and has been produced at great expenditure of time, labour and money. Carriage paid, Great Britain, 21/- net; Carriage paid to Foreign Countries and the Colonies, 23/- net.

THE
GRAMMAR OF LOGIC
(100 QUESTIONS ON)
OR
HOW TO REASON CORRECTLY

Post Free - - - - - - 1/6

By J. E. Roscoe, M.A.,
Vicar of Christchurch. Bacup.

AUTHOR OF
Dictionary of Educationists,
Confessions of Great Souls,
History of Theological Education, etc., etc. - - - -

REA & INCHBOULD,
Merton House, Salisbury Square,
London, E.C.4.

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CZECH CONTRIBUTIONS TO PLANT PHYSIOLOGY.

(1) *Neviditelné Bytosti* (Invisible Beings).

By PROF. BOHUMIL NĚMEC. Pp. 192. Prague: Státní Nakladatelství (State Publishing Office). 1926.

Prof. Němec's important volume on "Invisible Beings" is the third of a Czech series of "Books for Everyone." Its sixteen chapters deal with the life and peculiarities of the smallest organisms which constantly surround us but whose existence and presence can only be demonstrated by the use of a powerful microscope.

The development and propagation of the lowest plants and micro-organisms, the origin of life, biological evolution, the question of spontaneous generation and abiogenesis and heterogenesis are all adequately discussed. The characteristic of bacteria, sponges, protozoa, etc., and the activity of microbes (harmful and harmless) in the air, in water and in the soil are all touched upon and Prof. Němec concludes with a chapter on parasitism and symbiosis, *i.e.*, the relationship of plants which grow upon one another. Although written for the widest possible Czech public the author has included much that is new for students and specialists. Our knowledge of these organisms is far from complete and the lines upon which future discoveries will be made are indicated.

(2) *Rostlinná Biologie* (Plant Biology).

By PROF. BOHUMIL NĚMEC. Pp. 200, with many illustrations. Prague: Nákladem České Akademie Věd a Umění (Czech Academy of Science and Art). 1926.

Prof. Němec's second book deals with the *main processes of plant life.*

He begins by a general consideration of the question: "What is life and what are its manifestations?" The syntheses effected by plant substances even in the simplest cases, are chemically very complex and many complicated organic compounds are produced by both simple and more highly specialised plants.

A chapter is devoted to plant nutrition. The plant absorbs carbon dioxide, water, and mineral salts from external sources and uses them for synthesising fresh structures and also derives its energy from them. The growth of the plant is traced and the influence of external factors upon this growth is considered in some detail and the response of the plant to these changes is explained.

Attention is directed to the reproduction and mutation changes in plant species. The individuals are seen to have developed or evolved from simpler parents in order to adapt themselves better to circumstances and changed conditions.

The book is profusely illustrated. At the beginning are reproductions from Hooke's *Micrographia* (1667) to illustrate the cellular nature of plant tissue. Later there are many striking and original photographs in connection with parasitism and symbiosis.

Prof. Němec has investigated the parasitism of broomrape on ivy by growing ivy leaves in moist sand and then sowing seeds of the parasite which attached itself to the host as it grew. Symbiosis is well exemplified (*e.g.* the bean) and also by the fungi in the roots

of the saprophytic bird's nest orchid.

Whilst these works cannot appeal directly to English readers, they remain, nevertheless, valuable contributions to plant physiology.

J. G. F. DRUCE.

INTERNATIONAL CONFERENCE ON FLOUR AND BREAD MANUFACTURE.

By FRANCIS HRUSKA.

For the first time in the history of the Cereal Industry an International Conference on Flour and Bread Manufacture has taken place. This Conference was held in Prague ,Czechoslovakia, on September 22-25, 1927. More than 250 delegates (cereal chemists, millers, bakers, hygienists, etc.), representing thirteen European countries and the United States of America, took part in the Conference. The Conference was prepared by a special Preparatory Committee with Prof. Dr. Jelinek as President, with the co-operation of the Masaryk Academy of Work, Czechoslovakian Academy of Agriculture, and Association of Czechoslovakian Engineers. Its prgramme was divided into four groups :

(1) Working out the grain;
(2) Working out the flour;
(3) Consumption of the milling and baking products;
(4) International co-operation of cerealists, exchange of publications, etc.

Altogether, 50 papers were presented to the Conference dealing with all the subjects of the programme; 23 were from Czechoslovakia, 4 from Germany, 1 from Austria, 1 from Hungary, 3 from Holland, 1 from Italy, 5 from France, 3 from England, 6 from the United States of Canada, 1 from Canada. Official languages of the Conference were : Czech, English, French and German; according to this, 21 papers were read in Czech, 9 in English, 6 in French, 11 in German and 1 in Italian. The most important work of the Conference was the laying out the foundation for future International Congresses on Flour and Bread Manufacture; it was accepted to hold such Congresses bi-annually, the first of them to take place in Rome in 1929. An International Permanent Committee for organisation of these Congresses was created, the general secretary of it to reside in Prague. The statutes will be worked out by the Preparatory Committee of " Cerco " in Prague and presented to the first International Congress in Rome. A special sub-commission was created besides, with headquarters in Prague, to work out uniform analytical methods for cereal chemistry; as a basis for this work, the Book of Methods of the American Association of Cereal Chemists (A.A.C.C.) will be read.

The general report of the Conference containing all the papers which were presented together with the discussions, resolutions, etc., is to be published, the General Referee of the " Cerco," Francis Hruska, acting as Editor-in-Chief. Each paper will be printed in its original language with exhaustive summaries in all the remaining three languages. The price of the valuable book will be $3.50 and it will be sent to all members of the " Cerco," free of charge ;to all others interested, upon a special application mailed to the " Cerco " in Prague I.-606. The " Cereo " Committee hopes to find moral and financial support in every country where national committees for co-operation with the Prague Permanent International Committee should be created in the nearest future. The problems we have to face in the large field of cereal industries are too many and of too great importance to repeatedly postpone their international solution to distant future. They cannot be solved either by individual nations or countries but by an International body; the Prague Conference can certainly be considered as having laid foundations to such a solution.

RECENT DEVELOPMENTS IN AMMONIA LEACHING FOR ZINC ORES.

By H. M. LAWRENCE.

(*Bulletin of the School of Mines and Metallurgy, University of Missouri.*)

Progress in the development of ammonia leaching processes for zinc ores has not been as marked as in copper hydrometallurgy. Though basically sound, difficulties have been encountered in the application of the process to the treatment of zinc ores. The equipment and method of treatment has been considered expensive and complicated requiring close technical supervision in operation. Then, too, the zinc oxide produced was frequently of poor quality, and required further treatment. However, the development of ammonia leaching processes for copper tailings by Calumet-Hecla and Kennecott has demonstrated that large quantities of ammoniacal liquors can be utilised in commercial operations with but a small loss of the volatile reagent, and has

also resulted in the development of equipment, much of which is suitable for ammonia processes for the extraction of zinc.

During the past fifty years several investigators have studied the dissolution of zinc compounds by ammoniacal solutions; the majority have favoured the ammonia-carbon dioxide leach, though other solutions containing ammonia have been considered. It is well understiid that some zinc compounds, particularly the oxide, are dissolved by ammonium carbonate solutions; after purification of the solutions the zinc may be recovered from the liquors by distillation as a basic zinc carbonate, from which zinc oxide may be produced by calcination. The ammonia and free carbon dioxide that is not combined with the zinc are largely reclaimed by condensing and absorbing the vapours from the distillation. Other methods for the recovery of zinc from the distillation. Other methods for the recovery of zinc from the pregnant liquors, including electrolysis, have also been proposed.

SUMMARY.

Ammonia leaching, as a process for the extraction of zinc from complex ores or other zinc bearing materials, has certain possibilities that may be briefly pointed out.

(1) If calcines from the roasting of sulphide ores are treated, zinc extractions are likely, in general, to be somewhat lower with an ammonia than with a sulphuric acid leach. However, fewer impurities would be dissolved by the ammonium carbonate solutions and their subsequent removal should be more readily effected.

(2) If sulphide ores are fumed and an amenable fume product secured, treatment with ammonium carbonate solutions should yield high zinc extractions in a liquor that can be readily purified.

(3) Satisfactory recoveries of desired metal values from (1) or (2) should be made by smelting or other methods.

(4) If distillation of the purified pregnant liquors is practised, the precipitation of the zinc as basic carbonate or hydrate and the reclamation of the reagents should be effected with an economical steam consumption and with but little loss of ammonia. Oxide produced by calcining the precipitated zinc carbonate and hydrate would probably require refining to obtain a marketable grade of zinc oxide.

(5) The possibility of obtaining zinc as metal by electro-deposition from purified zinc ammonium carbonate solutions warrants investigation.

(6) For successful operation a well-designed plant, accessible for observation and repairs, is essential. Corrosion of equipment should be less than with ammonia processes for copper ores.

REVERSED SPECTRA OF METALS PRODUCED BY EXPLOSION UNDER INCREASED PRESSURE.

By MITSUHARU FUKUDA.
(*Inst. of Ph. and Chem. Research, Japan.*)

INTRODUCTION.*

The spectra of elements obtained in an ordinary arc are in general composed of emission lines. However under certain conditions lines are reversed, appearing black against the bright background. The reversal, in general, is due to the absorption of the emitted light by the zone of cooler vapour or less powerfully excited layer of the luminous gas which lies between the spectroscope and the source of radiation.

Reversals in the arc are most frequently seen for the lines of series converging at Es or 1S. However, many other lines belonging to different series show the same phenomenon. On the other hand, by careful consideration of reversed lines considerable information may be derived concerning series relations. Thus with alkali metals we find strong reversals of the pair belonging to the series $1s\text{-}2p_{1,\,2}$ which determines the value of the resonance potential.

The reversals may be double or triple under a certain excited condition, and further some of them are reversed asymmetrically.

In the present experiment, the self-reversals appearing in the special kind of excitation in increased pressures are examined, and at the safe time, by observing the results series relations of elements are discussed.

SUMMARY.

1. Spectrum of the several elements were studied by explosion using fine wires or strips under increased pressures. Spectral lines appeared in the experiment showed marked broadening with the increased pressures and also continuous spectrum between the lines appeared. Features of the broadened or reversed lines were the same with those of the Stark effect. Some minute descriptions on the points men-

tioned above are given. Moreover, many forbidden lines appeared not only as the emission lines but also absorption lines.

2. Some explanation on the origin of the widening of the lines are proposed by observing the features of the broadened or reversed lines. Two kinds of the reversed lines are noticed, one of them resembling the pure absorption lines and the other being the Stark effect separation.

3. Series relation of the multiplet spectrum was briefly discussed, and the unknown lines of the same elements were also discussed.

INTERNATIONAL INSTITUTE OF

Some 400 Delegates, Representing 60 Nations, Meet in Rome.

Inaugural Session of the "Agricultural Scientific Commission" and the "Permanent International Commission of Agricultural Associations."

In the presence of an impressive gathering of scientist technical experts and representatives of the Agricultural Associations, assembled at Rome from all parts of the world, was held on November 7, the First Session of the "Agricultural International Council" and the "Permanent International Commission of Agricultural Associations."

The total number of scientific delegations and agricultural representatives amounted to as many as 400, distributed among over 60 nations which proves the wide and firm foundations of these two original and opportune initiatives of the International Institute of Agriculture.

The main Assembly Hall of the Institute, was at an early hour thronged with members of the Congress, both men and women; and the presence of diplomatic representatives of the principal States further marked the importance of the occasion. Representatives of the greater internationl organisations and associations :—The League of Nations, the International Labour Office, the Inter-Parliamentary Conference of Commerce, the International Institute for the Scientific Organisation of Labour, International Confederation of Employers, the International Association of Lymnology, International Bureau of Domestic Economy, the Paris International Commision of Agriculture, the Italian Institute of International Law, the Italian Section International Law Association, the Hague International Institute, as well as special representatives of the Governments of Germany, Italy and France, and of the Universities of Toronto (Canada), were also present as observers.

The Ministry of Marine and the Ministry of Colonies sent two technical representatives to the special Commissions.

At 10.30 the Prime Minister, His Excellency Benito Mussolini, accompanied by the President of the International Institute of Agriculture, Professor De Michelis, by the Minister for Colonies, His Excellency Federzoni, by the Hon. Bianchi, Under-Secretaries of State, by the Governer of Rome, Prince Spada Potonziani, by representatives of the Chamber of Deputies, by dignitaires of the National Fascist Party, by the President of the E.N.IT., Senator Rava, by General Boriani of the Forest Militia, and by other anthorities and high State personages.

His Excellency Mussolini, in incisive words illustrated the purpose of the two new bodies that day entering on their functions, and which aim at completing and making potent the continued collaboration of science by the intermediary of the International Scientific Agricultural Council and the permanent International Commission of Aricultural Associations which ensure direct contact with agriculturists all the world over.

The Prime Minister, tendering his thanks to the Permanent Committee of the Institute and its President, stated that the meeting held that day represented the concrete and perfect realisation of the resolutions and wishes expressed for many years the institution of these new bodies whilst enabling the representatives of agricultural science and practice to make their voices heard directly in the sphere of the official representation of agriculture, should not alter the character of this State institution and should not diminish the independence of the Institute itself and of the adherent organisations.

After recalling the action taken by the Institute in many of the subjects submitted to the 27 technical scientific councils and of the Permanent Commission of Agricultural Associations, the Prime Minister concluded repeating the augural formula of the Roman sanatus consultus reproduced in the diplomas presented to the experts and expressing his most hearty wishes for the success of the labours of the Congress he now declared open. Enthusiastic applause marked the close of the speech.

On the invitation of the President of the Institute, the representative of Canada,

Prof. R. Thompson, rose to speak, and addressing Sig. Mussolini, expressed on behalf of himself and of those he represented, his admiration of the Italian renaissance in the social field and in the sphere of agriculture due to the work of the Fascist Government.

M. Alfred Massé, ex-Minister of Agriculture of France, expressing the views of his French colleagues, made a most hearty eulogism of the initiative of the head of the Italian Government in agriculture and laid particular emphasis on the wheat campaign, declaring it to be of capital importance not only for the economy of Italy but also for the welfare of the whole world.

The labours of the two important meetings commenced in the afternoon with a meeting of the plenary session.

As a souvenir, a young olive and a young oak tree were planted on the east side of the Institute's Park.

GENERAL NOTES.

GERMAN ATIFICIAL SILK INDUSTRY.

The Acting British Consul-General at Cologne informs the Department of Overseas Trade that the *Duetsche Bergwerks Zeitung* reports that, in spite of the great increase in German artificial silk production, there was an expansion of imports of foreign artificial silk during the first eight months of the year to 65,191 double zentner, as against 16,779 double zentner during January-August, 1926. This represents an increase of about 400 per cent., and it will be gathered that the interest in artificial silk has increased more than was originally assumed.

The German artificial silk industry, meanwhile, has not been behindhand. The big artificial silk mannfacturers have for some time been occupied in the extension of their works, which will shortly start operations. It should further be mentioned that the first workers have been engaged at the Cologne works of the Glanzstoff Courtauld G.m.b.H., and it may be expected, therefore that production will be begun shortly. In copper silk manufacturing the extensions started by the Bemberg Gesellschaft are nearing completion.

MINERS' WELFARE NATIONAL SCHOLARSHIP SCHEME.

The Trustees of the Miners' Welfare National Scholarship Scheme invite applications for a limited number of University Scholarships under the Scheme.

Candidates must be either workers in or about coal mines in Great Britain or sons or daughters of such workers, and must be not less than 17 years of age on 14 February, 1928.

Forms of application and full particulars may be obtained from the Secretary, Miners' Welfare National Scholarship Scheme, Mines Department, Dean Stanley Street, London, S.W.1. Applicants for forms must state whether they apply as workers in or about mines or as children of such workers, as the form is different in each case. Persons who come within both categories should apply as workers.

REPORT OF H.M. ELECTRICAL INSPECTOR OF MINES.

The Report for 1926 of Mr. J. A. B. Horsley, H.M. Electrical Inspector of Mines, which has now been published, contains much of interest to all electricians, managers, and others concerned with electrical equipment at mines.

Progress at mines under the Coal Mines Acts is analysed in detail. The total horsepower of motors installed was 1,620,145, or nearly 54,000 I.H.P., greater than in 1925. Electricity was used at 1,577 mines, a slight decrease compared with 1925.

DIRECTION OF FRENCH TRADE.

Imports into France from Great Britain during the first nine months of the year and merchandise moved in the opposite direction both showed slight decreases in value as compared with the corresponding period of last year. Imports from Germany, Italy, and the United States were smaller, but exports to Germany were substantially larger.

NOVA SCOTIA SUBMARINE COAL MINE ECLIPSES ALL PREVIOUS RECORDS.

The Dominion Coal Company on October 14 secured an output of 4,400 tons of coal from its No. 2 colliery at Glace Bay, which is the largest daily production on record since the mine was opened in 1898. On the same day No. 4 colliery raised 2,243 tons which, although not a record, was an exceptional showing for a pit which has been worked continuously and heavily for sixty years.

INSTITUTE OF CHEMISTRY.

JUBILEE CELEBRATION.

The Jubilee will be held under the patronage of H.R.H. The Prince of Wales on December 14 and 15.

On Wednesday, December 14, 1927, at 8 p.m., a Conversazione will be held at the Wharncliffe Rooms, Hotel Great Central, Marylebone. Every member of the allied Chemical Societies and Institutins is cordially invited to attend the Conversazione and to bring a lady guest.

Following a reception by the President and Council at 8 p.m., a programme of music will be provided and there will be dancing from 9.30 to 12.

On Thursday, December 15, from 10.30 a.m., until 12.30 p.m., at a Cinema in the West End of London, films will be shown illustrating British Industries in which Chemistry is applied.

Tickets will be obtainable by Fellows and Associates of the Institute and Members of the allied Chemical Societies and Institutions who indicate the number which they require on the card of acceptance.

Also on Thursday, December 15, the Institute Jubilee Dinner, to which a company of distinguished guests has been invited, will be held at the Wharncliffe Rooms, Hotel Great Central, at 7 for 7.30 p.m,.—the President in the chair.

THE ROYAL SANITARY INSTITUTE.

The 39th Congress is to be held at Plymouth from Monday, July 16, to Saturday, July 28, 1928, during which a Health Exhibition is to be held in the Drill Hall, near Millbay Station. It might be added that the Exhibition is certified by the Board of Trade as an Industrial Exhibition.

Municipal authorities throughout the Kingdom appoint a large number of official delegates to the Congress, in addition to the architects, engineers, and medical men who are members, and the ordinary visitors, so that the exhibits will be brought under the notice of members of Corporations and officials from all parts of the country.

Persons interested can obtain full particulars from the Institute, 90, Buckingham Palace Road, London S.W.1.

ROYAL INSTITUTION.

On Thursday, December 8, at 5.15 p.m., Mr. J. Kewley will give the first of two lectures at the Royal Institution, on "Petroleum Natural Gases and their Derivatives," and on Saturday, December 10, at 3 p.m., Dr. F. J. M. Stratton begins a course of two lectures on "Recent Developments in Astrophysics."

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

The following papers were read at the meeting held on November 10, 1927—

Density of the Vapour in the Mercury Arc and the Relative Intensities of the Radiated Spectral Lines with Special Reference to the Forbidden Line 2270. By B. VENKATESACHAR. Communicated by Lord Rayleigh, F.R.S.

The effect of altering the density of the vapour in a mercury arc (other conditions of excitation being kept unaltered) on the relative and absolute intensities of the radiated lines has been studied withiu the approximate pressure range of 2 mm. to 0.1 mm. of Hg. The current density employed ranged between 1.5 amps. cm.$^{-2}$ and 4 amps. cm.$^{-2}$. The effect of lowering the density of the vapour on the series lines in the arc spectrum (including inter-combination lines) is to increase the absolute intensities of all lines below $m = 5$ and diminish those of all lines above $m = 6$. It is pointed out that this result can be explained on the hypothesis that inelastic collisions between excited atoms in lower energy levels and thermally energetic normal atoms form the chief source of the radiators of the higher members of series lines. To the radiators of the lower members the contribution from this source is negligible. This accounts for the intensity diminution of the higher members when the vapour density is diminished. On increasing the vapour density collisions between the radiators of the lower members and normal atoms resulting in radiationless transitions increase and the intensities of these lines fall. The forbidden line 2270, like the lower members of other series lines, increases in intensity when the arc passes to the low density stage. This happens even when the current density is as high as 8 amps. cm.$^{-2}$.

Resistance to a Barrier in the Shape of an Arc of a Circle. By L. ROSENHEAD. Communicated by L. Bairstow, F.R.S.

The object of this paper is to obtain the resistance to circular barriers in accord-

ance with the discontinuous stream-line theory. The method is based upon the transformation introduced by Levi-Civita in 1906, and the approximation process used by Brodetsky. The value of the thrust and it line of action are obtained for barriers of both concave and convex camber, and for various angles of incidence. From these figures curves are plotted, from which the thrust for any particular camber and any possible angle of incidence can be obtained by interpolation. The results are interesting for the following reasons :—

(a) As the angle of incidence decreases, the centre of pressure, in the case of small concave cambers is found to move forwards till it reaches a maximum forward position, and then, as the angle of incidence decreases still farther, the centre of pressure moves backwards. This is more marked the smaller the camber.

(b) The effect of camber on the resultant thrust is seen to be much more marked with small angle of incidence than with large angle of incidence.

The Dielectric Constants of Ammonia, Phosphine and Arsine. By H. E. WATSON. Communicated by F. G. Donnan, F.R.S.

The dielectric constants were measured at temperatures near to - 47, 16 and 100° C. and at frequencies of approximately 800, 1050 and 1800 kc. A heterodyne method was used, and particular attention was paid to the measurement of stray capacities and to the corrections arising from lead inductance, in order to obtain accurate absolute values. The results were found to be independent of the frequency within the limit of experimental error, the mean values of a large number of observations being as follows :—

T.	NH_3	PH_3	AsH_3
-47	1099	337.3	251.0
16	659	238.1	191.6
100	406	168.7	146.0

the figures being theh values of $(\epsilon - 1).10^5$ at 1 atm. pressure. The accuracy of the absolute values is believed to be about 1 per cent. and that of the relative values somewhat greater.

The variation of $\epsilon - 1$ with pressure has been measured and the results indicate that this quantity is proportional to the density, although there is some uncertainty as to the compressibility correction. In the case of arsine the compressibility has been determined from the values of $\epsilon - 1$.

The results for the variation of ϵ with temperature are satisfied approximately by Debye's equation and the mean values for the electric moments of the molecules calculated by it are 1.49×10^{-18} for ammonia, 0.55×10^{-18} for phosphine and 0.15×10^{-18} or possibly less for arsine.

A Study of the Catalysts by Nickel of the Union of Hydrogen and Oxygen by a New Method. By D. R. HUGHES AND R. C. BEVAN. Communicated by D. L. Chapman, F.R.S.

When hydrogen and oxygen at a low pressure are caused to combine at the surface of a nickel wire heated electrically, there is no alteration in the appearance of the wire. The authors have shown, however, that the wire is covered completely with a very thin film of nickel oxide while the catalysis of the reaction is in progress. The extent of the surface covered by the film can be measured by estimating the heat lost by the wire when it is maintained at a fixed temperature in hydrogen at a low pressure. Under the same conditions the heat imparted to the hydrogen by a wire covered with a film is much greater than that communicated to the gas by a wire having a metal surface. The thickness of the films has been determined and found to vary between 3×10^{-7} cm. and 9×10^{-7} cm. We conclude that it is incorrect to speak of the catalysis of the interaction of hydrogen and oxygen by the metal nickel, but we consider that more than one theory of the mechanism of the reaction by nickel oxide is consistent with the facts at present known.

The Relative Stability of Nitrous Oxide and Ammonia in the Electric Discharge. By W. K. HUTCHINSON AND C. N. HINSHELWOOD. Communicated by H. Hartley, F.R.S.

A comparison of the relative ease of decomposition of ammonia and of nitrous oxide in discharge tubes at low pressure shows that, under a variety of conditions, ammonia is five to seven times as stable as nitrous oxide.

Since this ratio remains of the same order when different electrode materials are used, and when the discharge is passed through the two gases either in series or in parallel, it is probably justifiable to conclude that ammonia requires to decompose it ionic impacts of considerably more violence than thse required by nitrous oxide.

Studies of Gas-Solid Equilibria. Part I. By B. LAMBERT AND A. M. CLARK. Communicated by F. Soddy, F.R.S.

Pressure-temperature equilibria have been measured over a range 30° to 130° C. for

(a) ten systems containing different amounts of benzene and ferric oxide gel;

(b) eight similar systems containing different amounts of benzene and silica gel.

Highly accurate conditions of experiment have been worked out and used in these measurements.

Pressure-concentration relationships for benzene-ferric oxide gel systems and for benzene-silica gel systems have been "derived" from the results and isothermals have been drawn. There is a very striking difference between the *shapes* of the isothermals obtained for the two closely *analogous systems*.

It is clear that the adsorptive processes of the two gels for condensible vapours are profoundly different, and doubt is cast on Zsigmondy's Capillary Theory as a general explanation for adsorption of condensible vapours by inelastic gels.

A Magnetometer for the measurement of the Earth's Vertical Magnetic Intensity in C.G.S. Measure. By D. W. Dye. Communicated by Sir Arthnr Schuster, F.R.S.

An electrical magnetometer for the measurement of the vertical component of the Earth's magnetie field is described. The instrument consists of a Helmholtz coil system set up with its axis truly vertical. When the appropriate current traverses the coil system, the vertical component of the Earth's field is exactly neutralised. The resultant field is horizontal and directed along the magnetic meridian. This condition is indicated by the help of a small vibration detector.

The detector consists of a small and very light flat coil free to vibrate about a horizontal axis normally lying approximately in the plane of the magnetic meridian. The plane of the coil is vertical and the axis of vibration horizontal. The coil is traversed by a relatively large alternating current at its resonant vibration frequeney. Under these conditions it is very sensitive to a vertieal field. The condition of rest of the coil corresponds to a zero vertical field.

The sensitivity is equivalent to about 1γ. A series of tests consisting of frequent observations of V at interval of about two minutes give a base-line value from which the mean variation from the mean was 0.8γ, with a maximum difference of 2.5γ.

The paper gives the simple theory of the detector and shows the method of setting-up. and using the arrangement in order to attain the desired accuracy. Current-measuring arrangements are also discussed, an it is concluded that the whole installation enables a measure of vertical intensity in C.G.S. units to be realised to an absolute accuracy of about 2γ. Base-line values should be realisable to a reproducibility of 0.5γ.

The Spectrum of Carbon-Arcs in Air at High Current Densities. By J. W. Ryde. Communicated by A. Fowler, F.R.S.

A study of the spectra excited in high-current carbon-arcs in air has been made. The positive carbons were cored with metallic salts. Under suitable conditions, this allows steady arcs at high-current densities to be obtained.

As the current through such arcs is increased, a bright central core develops in the arc stream. In this core it was found that spectra of CI, NI, OI, together with the Balmer hydrogen lines and the strongest lines belonging to the red spectrum of argon are excited. The relative intensities of CI and NI lines, previously only found in special discharge tubes, are compared with those found in the arc stream.

Over fifty new lines were observed. These also are probably due to either NI, OI or CI. Five of these complete the NI Quarter System Multiplet 4P – P′ and two others belong to the 5P – P′ multiplet. Certain NI and OI lines were found to be displaced by amounts exceeding 2 A. in some cases. These lines are also much broadened.

The Swan bands are strongly excited close to and inside the positive crater, but they do not occur in the arc stream unless a jet of coal-gas is blown on to it, when they show brilliantly. Hydrogen alone is much less effective.

No helium lines were found, contrary to the report by Bell and Bassett. The lines they observed were prominent lines belonging to CI ,NI and OI spectra.

The Elasticity of the Collisions of Alpha Particles with Hydrogen Nuclei. By P. M. S. Blackett and E. P. Hudson. Communicated by Sir Ernest Rutherford, P.R.S.

Inelastic collisions involving the ejection of a proton from the nuclei of certain light elements are known to occur. It is not impossible that inelastic collisions may also occur without, however, a proton being ejected. For instance, the nuclei might be deformed without being disintegrated; or energy might be radiated by the rapidly accelerated particles. This problem can be directly investigated by precise measurements of photographs of the collisions taken by the Wilson Condensation Method. In

this paper the accuracy of the method is discussed and it is shown that the collisions of fast alpha particles with hydrogen nuclei provide tracks which are susceptible of great accuracy of measurement , and which therefore would reveal any small energy loss, should such occur.

Measurements are given of two such collisions, and it is shown that if any loss of kinetic energy occurs it must be less (for the most favourable of the two tracks) than 1/200 of the initial energy of the alpha particle; less, therefore, than 40,000 electron volts. If a quantum of radiation were emitted during the collision, its wave-length must be greater than 0.3 A.U.

The Refractive Index of Quartz. By W. R. C. COODE-ADAMS Communicated by T. M. Lowry, F.R.S.

The recent publication of a new series of values for the optical rotatory dispersions of quartz (Lowry and Coode-Adams, 'Phil. Trans.', A ,1927) has provided an opportunity for reconsidering the formula for the refractive dispersion of the crystal. Prior to this the characteristic frequencies in dispersion formulæ were obtained by indirect methods. They can now be obtained from the formula for optical rotation. By applying these to an equation of the Ketteler-Helmholtz type and solving for unknown constants the following equation is obtained :—

$$n^2 = 3.53445 + \frac{0.008067}{\lambda^2 - 0.0127493} + \frac{0.002682}{\lambda^2 - 0.000974} + \frac{127.2}{\lambda^2 - 108}.$$

Values calculated from this equation compared with the measurements of Gifford (' Roy. Soc. Proc.', vol. 70, 1902) show an average error of 0.00001 for 18 values for 7950 A.U. to 2144 A.U. Calculated values in the infra-red, when compared with the measurements of Carvallo (' C.R.' vol. 126, 1898) for 9 wave-lengths from 8007 A.U. to 13070 A.U., show an average error of 0.00008, and compared with measurements of Rubens and Nicols (' Ann. d. Phys,', vol. 60, 1897) for longer wave-lengths up to 4.26μ show an average error of 0.00004 for 13 values.

GEOLOGICAL SOCIETY.

The following paper was read at the meeting on November 2, Dr. F. A. Bather, M.A., F.R.S., President, in the chair :—

The Stratigraphical Distribution of the Cornbrash : I. The South-Western Area. By JAMES ARCHIBALD DOUGLAS, M.A., D.Sc., Sec.G.S., AND WILLIAM JOSCELYN ARKELL, B.A., B.Sc., F.G.S.

This paper gives an account of the stratigraphical distribution of the Cornbrash in South-Western England from Oxford to the South Coast near Weymouth. The evidence obtained by the Authors is used in a critical discussion of the eleven brachipod zones proposed by Mr. S. S. Buckman in a recent communication to the Society, and as a result a number of amendments in the list are suggested.

A general description is given of the faunal sequence, and the distribution of the zones throughout the area is indicated by a detailed account of many type-exposures.

The new records obtained are added to Mr. Buckman's faunal range-diagram, and in this way it is shown that many of his conclusions regarding penecontemporaneous erosion and non-sequences in the Cornbrash, as expressed in his clinal diagram, have been based on insufficient data, and that lack of geological information, in many instances due merely to exposure-failure or or faulty collection, has been used as evidence of stratal failure.

The introduction of new stratigraphical terms is criticised, and a twofold rather than a threefold subdivision of theh Cornbrash is advocated. The more important brachipods and lamellibranchs are discussed in palæontological notes, and several new species are described and figured.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

At the meeting at 16, Bedford Square, London, Mr. Luddington (Chairman) reported that the list of samples analysed for members by the Consulting Chemist during the months of August, September and October, 1927, had been submitted to the Committee.

Dr. Voelcker had reported that the Advisory Committee had concluded their labours, and had drawn up the regulations that were to accompany the new Fertilisers and Feeding Stuffs Act. These would be laid before Parliament in November, and, if then accepted, the new Act would come into force possibly on January 1, 1928, or at the latest by July 1, 1928.

The paragraphs in the Draft General Meeting Report had been considered and approved with slight amendments.

The Consulting Chemist had presented

the following report on matters arising out of his correspondence :—

REPORT OF CONSULTING CHEMIST.

1.—*Impure Wheat Offals.*

A member of the Society resident in Cambridgeshire sent me, early in August, a sample of " pollards " which he said he had found to be detrimental to his pigs.

On analysis I found this to contain :—

Mineral matter	9.77 per cent.
Including sand and silica	4.58 ,, ,,

The sample, though from wheat, was clearly a very dirty one, and such an amount of siliceous matter as is here shown should not be present in any purchased feeding stuff.

The purchaser was unwilling to give further particulars of the transaction than that the matter had been amicably settled.

2.—*Maize Germ Cubes not Equal to Description.*

A member farming in the Eastern Counties sent me a sample of what he had purchased from a Farmers' Co-operative Association as " maize germ cubes." This was guaranteed to contain oil 6 per cent., albuminoids 20 per cent., and it cost £10 10s. per ton delivered.

My analysis showed :—

Moisture	14.29
Oil	8.99
Albuminoids	13.06
Carbohydrates	60.68
Woody fibre	2.92
*Mineral matter	5.06
	100.00
Nitrogen	2.09
*Including sand	.20

It will be seen that this was below the guarantee as regards oil; moreover, the analysis was not that of maize germ, which would have about 10 or 11 per cent. of oil and 20 per cent. of albuminoids, but was more like that of maize meal.

3—*Ground Lime of Inferior Quality.*

A member resident in Surrey submitted for analysis a sample of ground lime purchased for liming land. It cost 37s. per ton delivered for a 3-ton lot. The analysis was—

Oxide of iron and alumina ...	1.99
Silica	7.26
Lime	66.08
Magnesia, carbonic acid, moisture, etc.	24.67
	100.00

Tough quite well ground and free from dirt, the sample contained a good deal of carbonate of lime, either because of imperfect burning or through subsequent exposure of the material for a considerable time, for it had only 66 per cent. of lime (CaO) altogether, whereas a well-burnt lime should have quite 80 per cent. or more.

The vendors admitted that there had been a mistake as to the quality supplied, and agreed to take the delivery back and supply good burnt lime.

THE CHEMICAL SOCIETY OF JAPAN.

Papers communicated :—

Satoyasu Iimori and Kaoru Kitaoka : " Bleaching of the Coloured Substance by Light."

Shinroku Mitsukuri and Yoshia Sakamoto : " On the Absorption Velocity of Carbon Dixoide hy the Still Surface of Caustic Soda Solution."

Saichiro Nagami : " Chemistry of Platinum Group Metals. Part VIII. Liberation of Chloroiridic Acid."

Saichiro Nagami : " Chemistry of Platinum Group Metals. Part IX. Electrolytic Dissociation of Chloroiridic Acid and Chloroplatinic Acid. Equivalent Conductance of the Salts of Platinum and Iridium at 18° and 25°."

Satoyasu Iimori and Uchu Kikuchi : " Some Constituents of the Petroleum from Maki, Echigo Province."

Eiichi Funakubo : " Studies on Indol-derivatives of Arsenic. Part I. Preparation and Properties of some Indol-β-arsonic Acids and the Evidence for the β-Arsonic Acid Structure."

NOTICES OF BOOKS.

O Povaze Věci. (Concerning the Nature of Things; translated from the English work of SIR WILLIAM BRAGG, by PROF A. ŠIMEK AND H. ŠIMOKOVA-KADLCOVA). Pp. 136 + 64. Prague : Jednota CS. Matematiku a Fysiku. 9927. Price 22.80 Czech crowns.

The volume *Concerning the Nature of Things*, by Sir William Bragg, will be familiar to many English readers both scientific and general. It was based upon Sir William's Christmas lectures to a juvenile audience at the Royal Institution in 1923-24, and an account of them appeared at the time (*The Chemical News*, 1924, CXXVIII, 26).

It is particularly gratifying that such a volume should be translated into Czech by Prof. and Mrs. Simek for the use of the young Czech students. In the preface the authors refer to the inaugural lecture by Michael Faraday of the series which now takes place every Christmas at the Royal Institution. The six on the Chemical History of a Candle were models of approaching the subject for young minds and still remaining scientifically accurate. The standard set by Faraday has been maintained by a long list of distinguished successors and those which are now presented for the benefit of Czech readers are also admirably suited to their purpose.

Prof. Simek alludes to the work of Sir William Bragg and his son, Prof. W. L. Bragg, on crystal structure, and the significant conclusion to be drawn, and he emphasises its importance to science generally. He finds the last three chapters of the book most interesting, likening the volume to Lucretius' poem *De Rerum Natura* for the enthusiasm which it inspires.

The book itself follows the original except that the illustrations are reduced to four-fifths of the size of those in the English work. Prof. Simek, who has also translated Prof. A. S. Russell's *Chemistry of Radioactive Substances*, deserves our best thanks for his efforts and we wish the translation every success.

J. G. F. D.

Recent Developments in Ammonia Leaching for Zinc Ores. Technical Series Bulletin, Vol. 10., No. 3, Missouri School of Mines ,Rolla Mo., U.S.A. By H. M. LAWRENCE, Metallurgist, U.S. Bureau of Mines. Published in co-operation with above Bureau.

This bulletin of 12 pages deals briefly with the history of the development of the process, reviews present-day operations, and gives tables showing results of experiments on roasted zinc ores; zinc-lead fume, and effect of improper roasting on zinc extractions. The author's conclusions are that ammonia leaching, as a process for the extraction of zinc from complex ores or other zinc bearing materials, has certain possibilities, which are listed.

SUMMARY.

(1) If calcines from the roasting of sulphide ores are treated, zinc extractions are likely, in general, to be somewhat lower with an ammonia than with a sulphuric acid leach. However, fewer impurities would be dissolved by the ammonium carbonate solutions and their subsequent removal should be more readily effected.

(2) If sulphide ores are fumed and an amenable fume product secured, treatment with ammonium carbonate solutions should yield high zinc extractions in a liquor that can be readily purified.

(3) Satisfactory recoveries of desired metal values from (1) or (2) should be made by smelting or other methods.

(4) If distillation of the purified pregnant liquors is practised, the precipitation of the zinc as basic carbonate or hydrate and the reclamation of the reagents should be effected with an economical steam consumption and with but little loss of ammonia. Oxide produced by calcining the precipitated zinc carbonate and hydrate would probably require refining to obtain a marketable grade of zinc oxide.

(5) The possibility of obtaining zinc as metal by electrodeposition from purified zinc ammonium carbonate solutions warrants investigation.

(6) For successful operation a well-designed plant, accessible for observation and repairs, is essential. Corrosion of equipment should be less than with ammonia processes for copper ores.

Copies of the bulletin may be obtained by writing to the Librarian, Missouri School of Mines, Rolla, Mo., U.S.A.

The Profession of Chemistry. By RICHARD B. PILCHER, O.B.E. (Registrar and Secretary of the Institute of Chemistry). Revised edition, prepared under the supervision of the Publications Committee of the Institute, with an introduction by Professor Arthur Smithells, C.M.G., D.Sc., F.R.S., President of the Institute. Pp. 9. Price 2s. 6d. net. Institute of Chemistry of Great Britain and Ireland, 30, Russell Square, London, W.C.1.

This is a most valuable book for all connected with chemistry, and also for those who are entering upon the study of chemistry. It is informative in every line, and is a guide as well as an instructor. There are 11 chapters, and a useful synopsis. The headings of the latter will give a fair idea of the range of the work. Education and Training, Preliminary Examinations, Technical Training, Qualifications (degrees, honours, etc.), Higher Qualifications, Possible Careers for the Chemist. The Secretary and President of the Institute are to be congratulated on the preparation of such a valuable handbook.

The Electronic Theory of Valency. By NEVIL VINCENT SEDGWICK. M.A. (Oxon.), Sc.D., D.Sc., F.R.S. Pp. xii + 310. Price 15s. net. London: Oxford University Press, Amen House, E.C.4.

The chapters of this important work are 15 in number, beginning with "The Nuclear Atom and the Atomic Number," and ending with "The Periodic Group." The author points out that in developing a theory of valency a chemist may use symbols with no definite physical connotation to express the reactivity of the atoms in a molecule; or he may adopt the concepts of atomic physics. He accepts the latter option, conforming to recognised terms and conditions, and devoting his main attention to explaining chemical facts on this basis. The result has been an informative book, thoroughly up-to-date, which can be studied with advantage by the student and the chemist who has left examinations behind him and who is now reaping the reward of his past labours in some responsible and, it is to be boped, adequately paid position. The work is well printed in prominent type on good paper and is strongly bound.

Analysis of the Arc and Spark Spectra of Scandium. Bureau of Standards, U.S.A., Scientific Paper No. 558. By Henry Norris Russel and William S. Meggers. Pp. 374. Price 20 cents.

A Modified Method for Determination of the Copper Number of Paper. Technologic Paper No. 354. U.S.A. Bureau of Standards. Price 5 cents.

Quantitative Analyse durch Elektrolyse. Begrundet von A. Classen siebente Auflage von A. CLASSEN UND H. DANNEEL. Pp. x + 399. Berlin: Julius Springer. 1927. Price 22m. 50 pf.

This important standard work on the electrolytic methods of quantitative analysis has reached its seventh edition being brought up to date in the subject which first became general after Classen's selection of methods in 1881.

Kolloidchemie von R. ZSIGMONDY. Pp. x + 256. Leipzig: Otto Spamer. 1927. Price 14 m.

The fifth edition of Prof. Zsigmondy's textbook has been considerably enlarged in the light of recent extensive work in colloid chemistry. It has been divided into two parts.

Die Alkaloide. By DR. GEORG TRIER Part I. Pp. 356. Berlin: Gebrüder Borntraeger. 1927. Price 18m.

Dr. Trier is engaged upon a revised edition of Prof. Winterstein's monograph on the naturally occurring organic bases. The present volume is Part I and covers those substances usually included in the aliphatic section of organic chemistry.

Abderhalden's andbuch der biologischen Arbeitsmethoden. Abt. I., Teil 2, 2 Halfte Price 10 m. Abt. I., Teil 2, 1 Halfte, Heft 4. Lieferung 240. Price 16 m. Berlin and Vienna: Urban and Schwarzenberg 1927.

In the first of these sections of Abderhalden's *Handbuch* Dr. Hans Sickel reviews the numerous methods for preparing amines and amides with special reference to the introduction of the NH_2-group into organic substances.

The second section by Dr. J. Halberkann deals comprehensively with the introduction of acyl and acetyl groups into organic compounds.

Plough Court: The Story of a Notable Pharmacy, 1715-1927. Compiled by ERNEST C. CRIPPPS. Pp. xviii + 227. London Allen & Hanburys, 37, Lombard Street E.C.3.

In 1518 the physicians obtained their charter and the apothecaries, their assistants, obtained theirs about a century later (1617). They were to sell drugs, and prepare or compound medicines according to the physicians' orders. The *Materia Medica* of that time was divided into "Galenicals and Chymicals." The former comprised herbs, roots and organic substances, while the latter were of mineral origin and were prepared by the "Chymists."

The firm of Allen and Hanbury was founded in 1715 by Timothy Bevan, who was styled by his contemporaries, "the Quaker F.R.S." He set a high moral standard in his commercial dealings, as did his co-religionists, and the firm soon began to prosper. being known, even then, for the purity and high quality of its drugs. He and his family interested themselves in suppressing evil practices at home and abroad, especially where it affected their business, and even to their own detriment. The tradition was carried on by William Allen (1770-1834) who joined the firm in 1792. He found time, however, to study chemistry and science generally by attending lectures at Guy's and St. Thomas' Hospitals. He became a member of many

societies, but it could not have been the Chemical Society to which he was elected a fellow in 1794, as stated on p. 26, for that society was not founded until 1841. He was actively associated with the movement for the abolition of the slave trade, and spent much time in endeavouring to hasten legislation in that direction. This brought him into contact with the great reformers of the period and also with royalty whose sympathy he won for his cause.

Other notable personages early connected with the Plough Court Pharmacy were Luke Howard (1797-1806), John Thomas Barry (1804-1856) an inventor of various stills, etc., and who was also interested in philanthropic work, and Daniel Bell Hanbury, one of the founders of the Pharmaceutical Society. His son, Daniel Hanbury (1825-1875), not only took an active part in the business, but also made many important contributions to chemical and botanical science, seven of which appeared in the *Chemical News*, which also reviewed his book "Pharmacography" (1875, xv., 282). The contact of these pioneers of the firm with other great minds of the times is referred to in the book. Much could also be said of the recent developments of this well-known firm of pharmaceutical manufacturers which now has several important branches at home and many connections overseas.

Plough Court is a noteworthy contribution to the history of the development of pharmacy and will dubtless be widely read in pharmaceutical and chemical circles.

J. G. F. D.

A Guide to the Literature of Chemistry. By E. J. CRANE AND AUSTIN M. PATTERSON. Pp. 438. Price 25s. net. New York : John Wiley and Sons, Inc. London : Chapman and Hall, 11, Henrietta Street.

The aim of the compilers of this work was ambitious, and the result of their labour has been on the whole creditable.

Books and periodicals occupy a large part of the book, and a good deal of labour has been expended in an endeavour to satisfactorily classify them. The authors dwell on the fact that most scientific books are out of date because of the new discoveries and inventions and other developments, from which it is safe to infer that at the end of a short period few of the never-ending flood of new and expensive books are of much value. In the circumstances the advice given not to buy books till they are wanted is a sound maxim. This fate of obsoletism, at least in some particulars, is inevitable in the case of the present work, but of course neither authors nor publishers can stave off misfortune.

I. G. FARBENINDUSTRIE A.G.

An interesting account of this great German combination (one of the largest and most progressive in the world) has been issued by the banking firm of Schwarz, Goldsmidt, and Co., of Berlin, W.8. The authors point out in their introduction that immediately the I. G. Farbenindustrie lost their coal-tar dyes monopoly in consequence of the war, they turned to the manufacture of artificial nitrogen. The firm relies on chemistry and other branches of science in the establishment of new industries. Recently they have laid down a large plant for the liquefaction of coal, and are now successfully manufacturing oil and benzene, and other developments are promised. Among the branches of industry in which the company is actively engaged, figure nitrogen products and fertilisers, wood and cellulose products, artificial silk, explosives, mineral colours, lacquers, solvents, resins, and divers other products. Works of various kinds and on a big scale have been established in various centres of Germany, while working arrangements have been entered into (or are being negotiated for) with large firms in Great Britain, the U.S.A., and other countries. It would not be exaggerating to say that the company is one of the most powerful and progressive, not only in Germany (a country famous for progressive firms), but in the world.

FORTHCOMING EVENTS.

BIO-CHEMICAL SOCIETY.

Lister Institute, Chelsea Gardens, London. Monday, December 5.

INSTITUTION OF CHEMICAL ENGINEERS.

Conference at the Chemical Society's Rooms, Burlington House, Piccadilly, London, W.1., on Wednesday, Thursday, and Friday, December 7, 8 and 9, 1927.

Wednesday, December 7, at 5 p.m.—"Submerged Flame Combustion." By

Norman Swindin, A.M.I.Mech.E. (Member). Chairman The President, Sir Alexander Gibb, G.B.E., C.B.

Thursday, December 8, at 5 p.m.—"*The Design of Refrigerating Plants.*" By G. W. Daniels, M.Eng., Wh.Ex., A.M.I.Mech.E.

"The Practical Aspect of Refrigeration as Applied to the Chemical Industry." By Leuig Chew, M.I.Mech.E.

"Electrical Automatic Refrigerators for Domestic Use." By Raymond J. Mitchell, M.I.Mech.E., M.I.E.E.

Chairman: J. Arthur Reavell, Esq. (Vice-President.)

Friday, December 9, at 5 p.m.—"The Problem of Industrial Lighting, with some Reference to the Chemical Industry." By W. J. Jones, M.Sc., A.M.I.E.E.

Chairman: W. A. S. Calder, Esq. (Vice-President.)

Friday, December 9, at 8 p.m.—"Continuous Weighing of the Contents of Vessels: The Weighmeter." By R. G. Parker, B.Sc., F.I.C., D. N. Jackman, M.Sc., A.I.C., and J. N. Vowler.

"The Properties of Silica and Fireclay Refractories in Relation to their Industrial Usage." By A. T. Green, F.Inst.P. (Associate-Member.)

INSTITUTION OF CHEMICAL ENGINEERS.

Abbey House, Victoria Street, London.

Wednesday, Thursday and Friday, December 7, 8 and 9.

INSTITUTE OF METALS.

At Society of Motor Manufacturers, 88, Pall Mall, London.

Thursday, December 8, at 7.30 p.m.—"Strip Casting," by W. A. Newman, B.Sc., F.I.C.

N.E. Coast Section, at Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne.

Tuesday, December 6, at 7.30 p.m.—"Hot Extrusion Process." By J. E. Newson, M.Met.

Sheffield Section, at Applied Science Department, University, St. George's Sq.

Friday, December 9, at 7.30 p.m.—"Stresses in Non-Ferrous Castings," by Prof. C. H. Desch, D.Sc., Ph.D.

Swansea Section, In Thomas' Cafe, High Street.

Wednesday, December 7, at 7 p.m.—"Extrusion," by R. Genders, M.Sc.

INSTITUTE OF PETROLEUM TECHNOLOGISTS.

Tuesday, December 6.—Dinner.

OIL & COLOURMENS' ASSOCIATION

8, St. Martin's Place, Trafalgar Square, London.

Thursday, December 8.—"The Application of X-rays to Industry." By G Shearer, M.A., D.Sc.

Manchester Section, at Milton Hall.

Friday, December 9, at 7.30 p.m.—"The Application of Methods of Dyestuff Analyses on the Examination of Pigments and Lakes." By Prof. Arthur G Green, F.R.S., M.Sc.

ROYAL INSTITUTION OF GREAT BRITAIN.

Albemarle Street, London, W.1.

Monday, December 5, at 5 p.m.—General Meeting.

Tuesday, December 6, at 5.15 p.m.—*Sir William Bragg*: "A Year's Work in X-ray-Crystal Analysis."

Thursday, December 8, at 5.15 p.m.—Mr. J. Kewley "Petroleum Nautral Gases and their Derivatives."

Saturday, December 1, at 3 p.m.—Mr. F. J. M. Stratton: "Recent Developments in Astrophysics."

ROYAL INSTITUTE OF PUBLIC HEALTH.

3, Russell Square, London.

Wednesday, December 7, at 4 p.m.—"The Health of the Public School Boy." By L. R. Lempriere, O.B.E., B.A., M.B.

ROYAL SOCIETY OF ARTS.

John Street, Adelphi.

Wednesday, December 7, at 8 pm.—S. J. Duly, M.A., Head of Department of Commercial Products, City of London College, Mitchell Student for 1925-6: "Th

Damage to Cargo due to ' Ship's Sweat.' "

Monday, December 5, at 8 p.m.— (Cantor Lecture). Professor Henry C. H. Carpenter, M.A., Ph.D., F.R.S.: " Alloy Steels, their Manufacture, Properties, and Uses." (Lecture IV.)

Indian Section.

Friday, December 9th at 4.30 p.m.— " The Indian Tariff Board," by Sir David Chadwick, C.S.J.

SOCIETY OF DYERS & COLOURISTS.

Manchester Section.

Friday, December 9.—Joint meeting with the Manchester Section of the Institution of Rubber Industry: " The Colouring of Cold Cured Rubber." By W. E. Sanderson, A.I.C.

SOCIETY OF PUBLIC ANALYSTS.

At Burlington House, London W.1.
Wednesday, December 7.

The next Meeting of the Society will be held on Wednesday ,December 7, at the Chemical Society's Rooms, Burlington House, Piccadilly, W.1., at 8 p.m. The following papers will be read :—Demonstration of Apparatus (i) Apparatus for Determining Benzoic Acid in Foods. By G. W. Monier-Williams, O.B.E., Ph.D., F.I.C. (ii) Sodium Flame for Polarimetric Work. By T. McLachlan, F.I.C., and A. W. Middleton. ALxDj Middleton. " Oil Bromide Films and their Use in Determining the Halogen Absorption of Oils." By Harold Toms, M.Sc., A.I.C. (Work done under the Analytical Investigation Scheme.) " Tests for Impurities in Ether." By G. Middleton, B.Sc., A.I.C., and F. C. Hymans, B.Sc., A.I.C. " Arsenic in Coated Papers and Boards." By Harold J. Stern, B.Sc., Ph.D., F.I.C.

Eight Candidates for admission to the Society will be balloted for.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Victoria Embankment, London.

Monday, December 5, at 7 p.m.—Informal Meeting. Discussion on " Air Heating and Conditioning," opened by Mr. N. E. Jackson.

East Midland Centre, at The College, Loughborough.

Tuesday, December 6, at 6.45 p.m.— " Modern Electrical Wiring as Applied to nall Houses." By D. S. Munro.

Tees-side Sub-Centre, at the Cleveland Technical Institute, Middlesbrough.

At 7 p.m.—Address by Mr. H. Paterson, Chairman, N.E. Centre.

THE PHYSICAL SOCIETY.

At the Imperial College of Science, Imperial Institute Road, S. Kensington, London.

Friday, December 9, at 5 p.m.

THEOSOPHICAL SOCIETY.

At Imperial College of Science and Technology, South Kensington.

Thursday, December 8, at 7.30 p.m.—Ordinary Meeting.

UNIVERSITY COLLEGE.

Gower Street, London.

Tuesday, December 6, at 5.15 p.m.— " The Equipment of a Mediæval House." A public lecture by Mr. H. Clifford Smith, F.S.A., Assistant Keeper, Victoria and Albert Museum. (Lantern Illustrations.)

SOCIETY OF CHEMICAL INDUSTRY.

London Section, Central House, Finsbury Square, London, E.C.2.

An Ordinary Meeting of the Section will be held at Burlington House, Piccadilly, W.1., at 8 p.m., on Monday, December 5, when Dr. H. S. Hatfield will read a paper on " Automatic Analysis of Liquids and its Application to the Control of Water Softening Plants."

The President and Council of the Institution of Chemical Engineers hae extended to all members of the London Section of the Society of Chemical Industry, an invitation to attend the Conference to be held on December 7, 8, and 9, 1927. It is hoped that many members will be able to attend.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

29,756.—Allchin, L. J.—Dyes. November 7th.

30,025.—Hellriegel, E.—Process for producing N-monoalkyl derivatives of

30,046.—I. G. Farbenindustrie Akt.-Ges. —Production of throurea. November 9th.

80,092.—Whitaker, R. J.—Chemical, etc., tablets. November 9th.

29,764.—I. G. Farbenindustrie Akt.-Ges. — Manufacture of condensation products from urea. November 7th.

Specifications Published.

279,916.—Dreyfus, H. — Manufacture of aliphatic acid anhydrides.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

AUDAX BRAND.

483,753.—Chemical substances prepared for use in medicine and pharmacy. —H. R. Napp, Limited, 3 and 4, Clements Inn, Kingsway, London, W.C.2. November 16th.

SANESCOL BRAND.

484,397.—Chemical substances prepared for use in medicine and pharmacy. —H. R. Napp, Limited, 3 and 4, Clements Inn, Kingsway, London, W.C.2. November 16th.

ISTICOL BRAND.

484,517.—Chemical substances prepared for use in medicine and pharmacy. —H. R. Napp, Limited, 3 and 4, Clements Inn, Kingsway, London, W.C.2. November 16th.

MENTEX.

483,025.—Chemical substances in class 1 which includes acids, potash, salts and other chemical substances used in manufacturers.—The Paisley Oil and Chemical Company, Limited, Trading Estate, Slough, Buckinghamshire. November 16th.

GERMAN CONVERSATION AND LESSONS GIVEN.

Translations Undertaken.

Write, S. G., c/o *Chemical News*, Merton House Salisbury Square, London, E.C.4.

GENERAL INDEX TO THE

"CHEMICAL NEWS"—VOLS. 1 TO 100.

This large volume contains a detailed Index to the first 100 volumes of the *Chemical News*, and will be found of great value to all interested in Chemical, Engineering, Electrical and General Scientific subjects. It has been compiled with great care, is handsomely bound in red cloth, and has been produced at great expenditure of time, labour and money. Carriage paid, Great *Britain, 21/- net; Carriage paid to* Foreign Countries and the Colonies, 23/- net.

THE

GRAMMAR OF LOGIC

(100 QUESTIONS ON)

OR

HOW TO REASON CORRECTLY

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Confessions of Great Souls,
History of Theological Education, etc., etc. - - - -

REA & INCHBOULD,
Merton House, Salisbury Square
London, E.C.4.

THE CHEMICAL NEWS

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AN ATOMIC MODEL FOR THE CHEMIST.—VII.

By FLORENCE LANGWORTHY.

In the Address by Dr. Sidgwick on "Co-ordination Compounds" to the Chemistry Section of the British Association, there is the following passage:—"Werner's Theory of Co-ordination, which was first put forward in 1891, the year after our last meeting at Leeds, originated in an attempt to explain the structure of certain compounds formed by apparently saturated molecules with one another. . . The most marked peculiarities of these compounds were three. In the first place their structure appeared to be quite independent of the ordinary rules of valency, according to which the numerical value of the valency of an atom element was primarily determined by the group in the periodic table to which it belonged, first rising and then falling by single units as we go from one group to the next. In these compounds the structure was rather determined by the group in the periodic table to which it belonged, first rising and then falling by single units as we go from one group to the next. In these compounds the structure was rather determined by the tendency of four or six atoms or groups to arrange themselves round a central atom. Secondly, in these complexes, a univalent atom or group of atoms such as chlorine or NO_2 could be replaced by a whole apparently saturated molecule such as water or ammonia without affecting the stability of the complex. Thirdly, such replacement was always accompanied by a remarkable change in the ionisation of the molecule. Thus platinic chloride $PtCl_4$ combines with six molecules of ammonia forming a compound $Pt(NH_3)_2Cl_4$ in which all four chlorine atoms are ionised. As the ammonia molecules are removed one by one, the chlorine atoms appear to take their places in the non-ionised part of the molecule, until we reach $Pt(NH_3)_2Cl_4$ which is not ionised at all, and is not a salt; every replacement diminishes the positive charge on the platinum complex by one. If more ammonia molecules are replaced by chlorine atoms, the ionisation occurs again, but now the complex has acquired a negative charge, so that we finally reach the well-known 'double-salt' K_2PtCl_6."

Using our atomic model, we will picture these changes. The central atom in this case is the platinum atom and as its major planets are alone concerned, we will omit the platinum planet and its fellow minor planets in addition to the coronal electrons. We will simply indicate the major containing nine sun-atoms, and the major planets, of which the thulium planet is the outermost. To the tungsten, tantalum, hafnium, and lutecium planets four chlorine atoms have attached themselves by repelling away the negative particle belonging to each positive planet, and then uniting themselves with these positives. Thus only the ytterbium and thulium planets still possess their negative particles. When the molecule of platinic chloride has six molecules of ammonia added to it we can understand that the four chlorine atoms will be highly ionised since three positive hydroge

atoms have been brought into the vicinity of each one.

Tu	Yb	Lu	Hf	Ta	W
0	0	0	0	0	0
.0.	.0.	Cl	Cl	Cl	Cl
NH_3	NH_3	NH_3	NH_3	NH_3	NH_3

When we start taking away the ammonia molecules it is also easy to understand that the more excited ones—those attached to the chlorine atoms—are likely to be attracted away first and so the molecule is left with the two ammonia molecules that *are attached to the thulium and ytterbium* planets of the platinum atom. Thus it is not necessary to picture the chlorine atoms as moving to a "non-ionised part of the molecule." The two remaining ammonia molecules are not in contact with the chlorine atoms and so the molecule is no longer ionised. The taking away of the four ammonia molecules leaves the four negative chlorine atoms to the front and so the molecule has lost four positive charges and has gone back now to its platinic chloride state save for the two ammonia molecules on the *two outermost planets. If we now replace* the two ammonia molecules by chlorine atoms ionisation may well occur again, seeing that each chlorine atom will be repelling away the negative particle of each planet and joining up with the excited positive. But this ionisation will soon die down as there are not three positive hydrogen atoms in the vicinity of each chlorine atom now to keep that negative in an excited state.

In the diagram atoms are shown as linking up more intimately with the central atom than molecules. The chlorine atoms, for instance, have repelled away the negative hooks attached to the positive planets and taken their places thus becoming, as it were, *part of the platinic system.* But the two molecules of ammonia that have joined up with the thulium and ytterbium planets have not made this intimate linkage. They remain simply two positive molecules within the sphere of attraction of the two negative hooks of these planets, even as if they were the gold and mercury planets of the next system.

We have pictured a chlorine atom as being excited by the presence of an ammonia molecule with its three positives, we can understand that there is ionisation when *these two part as well as when they meet.* It has not really had a chance of dying down. When, however, a chlorine atom joins up with another chlorine atom by repelling away one of its negative hooks and so making it slightly more positive than itself, the ionisation may well be slight and die down not to be reawakened at parting. Such a molecule, therefore, when dissociated into atoms would be uncharged. Our atomic model shows us that chlorine atoms and other minor planet atoms cannot become double-positives by gaining another positive as the major planet atoms can do. And so it will follow that although the chlorine pair are practically alike, a nitrogen pair can be practically alike in N_2 and yet different in N_2^{+}. Even so we shall have a CO in which both carbon and the oxygen atoms lack the double-positive and so be more or less neutral, or the same molecule in which either the carbon atom or the oxygen atom is a double-positive, making its appearance as such in the Positive Rays.

Dr. Sidgwick refers to sulphur hexafluoride as "one of the most stable of known compounds." With this atomic model it is easy to see why this should be the case. The linkage is a negative one, or, in other word *six strong negative atoms* have ousted six weak negative hooks and attached themselves to the very planets of the sulphur atom—as the chlorine atoms have attached themselves to the platinum atom in the diagram shown. Linked to positives thus the strong negative atoms may well go to the making of a stable compound. Let us compare this with a positive linkage where a positive atom attaches itself to one of the negative hooks of an atom—as in the case of the OH molecule. On joining up with the negative the hydrogen atom apparently *has its electron repelled to a great distance* from it, though it still keeps its pull upon it, thereby continues to give it the weight of one. (To this repulsion of the electron the explosive energy of the union will be due, the electron being the energy quantum). But though the positive hydrogen atom has succeeded in uniting itself with the negative hook of one of the planets of the oxygen atom, it has to contend with the positive repulsion of the planet. A union in which two positives share a negative cannot be so binding as one in which a negative has undisturbed possession of a positive.

Our atomic model with its six major planets would seem to throw some light upon the part that "six" plays in the problem of valency. But does it show us why the above-mentioned sulphur atom, for instance, can hold up six negative atoms

and yet only two positive atoms. I venture to think it does. If we bear in mind the way this atomic model is built up we might, at first, be tempted to say that the sulphur atom should be able to hold up six positives seeing that its major planets hold up the six positives that are thrown to them when the atom is built up from potassium to chromium. But in this case we should be leaving out of account the new sun-atom and its electron-planets that belong to the system containing the potassium-chromium planets. These electron-planets prevent the coronal electrons of the potassium-chromium planets from escaping and so these positives may well be help up. But when a hydrogen atom or any other positive atom attaches itself to a sulphur atom it has no coronal electrons in the atomic system of the sulphur atom. It is simply a separate atom that has been attracted. All that is holding it up is the attraction of the negative particle attached to the positive planet and this positive planet will, by its repulsion, be doing its best to keep the intruding positive at a distance from the negative particle. We can see, therefore, that since this repulsion is reinforced by that of the sun-atom whenever it is roused, the outside positives have more difficulty in combining with the sulphur atom—or any other atom—than the outside negatives. What appears to be the case is that the sun-atom will tolerate a certain amount of positivism in its system but no more. It will suffer one positive to be held up when the system is fluorine, for instance. On the departure of the fluorine planet, the sun-atom of that system has lost one positive and so it will tolerate the holding up of two positives by the oxygen atom. The flight of the oxygen planet entails the loss of another positive and so the nitrogen atom can hold up three positives. When the nitrogen planet goes, the atom has lost still another positive and so the carbon atom can hold up four positives. The loss of the carbon planet should allow the boron atom to hold up five positives, but now there are only three negative hooks left. So the boron atom has to content itself with three positives as its limit; the beryllium atom with two, and the lithium atom with one. Each new system will have the same conditions imposed upon it by its new sun-atom.

It may be objected that a nitrogen atom can hold up four hydrogen atoms, but apparently it can only do so temporarily while the atom is greatly excited and when the union has been effected with the aid of a negative. Let us picture, by way of example, an excited molecule of H_2O approaching a molecule of NH_3. The oxygen atom is excited for not only are there three hydrogen atoms instead of two attached to the nitrogen atom, but the latter in itself is also more positive. We will, then, picture the oxygen atom in H_2O as being drawn towards the NH_4 molecule and thereby having one of its hydrogen atoms repelled away from it since that makes it too positive to be tolerated. The oxygen atom repels away a negative hook from the nitrogen atom and links up with the planet as the negative OH. The repulsion of the negative particle will have excited the negative attached to the one remaining free planet of the nitrogen atom with the result that the repelled hydrogen atom can attach itself to it. The sun-atom will now tolerate this union because an oxygen atom has been added to the negativism of the system. And when OH departs the extra positive may well retain its hold for a little longer until the excitement among the planets, due to that loss, dies down.

How, then, are we to interpret the following? "The fact that gases such as hydrogen chloride and ammonia are intensely soluble in water is clearly a proof that their molecules are greatly attracted by and have a great attraction for water molecules; it is remarkable, however, that although hydrogen chloride and ammonia are easily soluble in water and also combine readily with one another, they are gases which are by no means easily condensed—in other words, the molecules in each gas have little tendency to associate among themselves." We should surely say that the molecules of these gases are not easily condensed because their neutrality is only a surface neutrality. The chlorine atom as a strong negative is in an unsatisfied, unsaturated condition because it ought to be able to hold up more positives than one, but cannot on account of the way the atom is built up. And so there is a latent excess of negativism in the hydrogen chloride gas which keeps its molecules well apart. On the other hand the much less negative nitrogen atom is holding up three positives so that beneath the apparent neutrality of the ammonia there is an amount of positivism that serves to keep its molecules at a distance from one another. Since there is this difference between the

two gases they may well combine readily with one another.

In a recent number of the *Chemical News* evidence was adduced that showed that the molecule H_2O is positive when excited—not neutral. Seeing that the water molecule is composed of an unknown number of these H_2O molecules it is possible that it originates in the following way. One of the H_2O molecules loses its hydrogen atoms with the consequent excitation of the six negative hooks of the oxygen atom, the which attract six H_2O molecules. It may be objected that this polymerisation means that the oxygen atom is holding up six positives. But they are not pure positives. The sun-atom has been shown as not tolerating more than two pure positives in the oxygen system; it does not, however, follow that the sun-atom will not tolerate such positives if they bring negatives—especially such negatives as oxygen atoms—with them. The positivism of the sun-atom is placated by the presence of the negative oxygen atoms. This water molecule, $O + (H_2O)_6$ would account for the hexagonal form of the unit as seen in snow and ice. And its formation would account for its being neutral since the negative oxygen atom is there to counterbalance the positive molecules of H_2O.

We should not expect this molecule of $O + (H_2O)_6$ to remain stable if two such gases as those above-mentioned are brought into its vicinity. When we put hydrogen chloride molecules into water we are putting strong negative atoms like chlorine atoms into juxtaposition with the positive water vapour molecules. What happens, apparently is that the chlorine atom in HCl tries unsuccessfully to join up with the H_2O molecule and thereby has its hydrogen atom repelled away from it. This loss on the part of the chlorine atom tempts one of the hydrogen atoms away from one of the H_2O molecules to join up with the stronger negative. By thus leaving the oxygen atom it becomes ionised. Electrolysis shows us that " the products actually evolved are hydrogen and chlorine, also the ions, hydrogen and hydroxyl, resulting from an increased dissociation of water, the latter interacting with chlorine to reproduce hydrogen chloride and oxygen gas."*

Again when we put ammonia molecules into water we are putting molecules containing three positives into juxtaposition with molecules containing only two. The oxygen atoms in the latter are excited since they would hold up more positives if they could. So the oxygen atoms joins up with the nitrogen atom in the ammonia molecule and in so doing has one of the positives attached to it repelled away from it, the which is finally attracted to the last free negative hook of the nitrogen atom. And as the latter is negative the sun-atom tolerates the extra positive for awhile.

It may be objected that in electrolysis the copper atom is divalent and the gold atom *trivalent. Unlike the tin atom with* its four hooks, the calcium and zinc atoms with their two hooks, the copper and the gold atoms have only one hook. Since the silver atom has a valency of one it would seem that this abnormal behaviour on the part of the copper and the gold is due to their superior attractive power. One may suspect that copper has far more of its atoms broken-down to the double-positive stage than silver. Thus silver would be offering a negative or a single positive attraction while copper would be offering a double positive one. That gold should have high attractive power, we can understand, since not only is it the last element of group one, but it also contains the extra positives that have been added to the atom in the building up thereof (as, for instance, in selenium, tellurium, cadmium, tin, etc.). This extra attractive power possessed by these two elements apparently enables them to hold up atoms in a short chain. Thus in gold trichloride we can picture a molecule of chlorine as holding up an atom of gold, the which, in its turn, holds up an atom of chlorine. The chlorine atom (A)—in the molecule—which is holding up the chlorine atom (B), could hold up more negatives than B. The latter, in its turn could not hold up more positives than the pure positive gold atom. But if it had been a case of impure positive molecules, the two chlorine atoms between them could have held up eight H_2O molecules (Chlorine Hydrate). In its turn the gold atom holds up another chlorine atom. In such a molecule as Au $(OH)_3$ it is possible that the one of the oxygen atoms is holding up—as its two positives a gold atom and a hydrogen atom, while two negatives in the form of two OH molecules are attached to two more of its hooks. In Sodium Aurosulphide, the sulphur atom appears to be holding up the other atoms, two pure positives, its share) in the gold atom and the sodium atom, and

* Sir William Tilden, F.R.S. *Chemical Discovery and Invention in the Twentieth Century*, p. 188.

four impure positives in the four molecules of H_2O. Thus its six hooks would be engaged.

If we bear in mind that in electrolysis we *have the current entering at the anode*, that is to say, the atoms near it will be the first to be roused, or, what is more important, have their sun-atoms aroused, we shall *not be surprised to find that the more positive of these atoms will drift down to the cathode, while the more negative atoms will be attracted to that centre of positive activity, the anode.* A roused sun-atom is *far more potent in a positive atom* since there is no negative system to counterbalance it.

In washing soda (Na_2CO_3. 10 H_2O) the *carbon atom appears to be holding up three* positives (two sodium atoms and one double-positive oxygen atom) out of its limit of four. The other two oxygen atoms, as negatives, would thus be holding up five each of the impure molecules of H_2O with their remaining five hooks.

That heat should set these molecules of water vapour free and yet be engendered *when they join up again* we can understand with this atomic model, since they are only tolerated in the atomic system by the sun-atom and once the latter is aroused by heating *they are repelled away. On their* joining up again the sun-atom is quiescent and the heat engendered does not affect the sun-atom but ourselves since it would be due to the repulsion by *the negative particles of the hooks of the outer electrons* of the H_2O molecules. When each of the latter was free its two outer electrons were not at a very great distance since it is a positive molecule, but *when it joins up with a negative oxygen atom*, then the repulsion of the negative hook will come into play and repel the electrons to a greater distance, thus *giving us an exothermic compound*. Had the electrons been attracted, instead, we should have had an endothermic one.

ROYAL SOCIETY MEDALS

Presentation of Medals.

At the anniversary meeting on November 30, the following medals were presented by the President, Sir Ernest Rutherford :—The Copley Medal to Sir Charles Sherrington, a Royal Medal to Sir Thomas Lewis, and the Buchanan Medal to Dr. Greenwood. A Royal Medal has been awarded to Professor J. C. McLennan, the Hughes Medal to Dr. W. D. Coolidge, and the Davy Medal to Professor A. A. Noyes, but they were unable to be present to receive their awards.

GENERAL NOTES.

POWDERED RESULTANT FUEL.

Tests this week at a North country engineering works throw fresh light on markets for British coal. Scottish coal in its raw state was tried out before an independent technical authority against powdered resultant (or " L. & N.") fuel, distilled from the same coal. On a strict comparison with the performance of the raw coal the amount of power for pulverising " L. & N." fuel cropped by 25 per cent.; the furnace temperature rose from 1,150 to 1,560 ; the steam pressure in the boiler *was even slightly higher*; while the CO_2 content of the flue gas was up to 17 per cent.

It may be recalled that paraffin lamps *used to explode freely, until distillation of* the lighter hydrocarbons from the paraffin raised the flash point. Similarly the " L & N " process of control raises the flash point of its resultant fuel above that of oil. In view of these tests the adoption of this distilled fuel or steam-raising in the Merchant Marine may shortly be looked for.

IS THE SUCCESSFUL MANUFACTURE OF SYNTHETIC RUBBER IN SIGHT?

An impression that may be gained from reports of the speech recently made in *Frankfort* by Geheimrat Dr. H. von Weinberg, of the I. G. Farbenindustrie, at the 50th anniversary meeting of the Society for the support of the German Chemical Industry (Verein zur Wahrung der Interessen der Chemische Industrie Deutschlands), is that successful manufacture of synthetic rubber is in sight.

This impression may be discounted by the following translation received by the Department of Overseas Trade from His Majesty's Consul-General at Frankfort (Mr. V. H. C. Bosanquet) of the pertinent *passage in the speech from the report* appearing in the *Frankfurter Zeitung* :—

> " Through contact synthesis we shall further succeed in extracting by a more convenient method the raw materials for the synthesis of rubber and gutta percha."

In another translation made at the Consulate-General in Cologne from a report in the *Deutsche Bergwerks Zeitung*, the end of the sentence reads, " *to produce* the elements for the synthesis of rubber and gutta percha."

The only interpretation possible is that *the German chemical combine* with which Dr. V. Weinberg is connected has become

satisfied with the progress made in its investigations towards the production of isoprene, or a related hydrocarbon, from which the rubber molecule must be built by further treatment. The reports do not mention the second and very difficult problem, that of obtaining a material which will present the essential physical and mechanical qualities of natural rubber.

INSTITUTE OF CHEMISTRY.

Jubilee Celebration : 14-15 December, 1927.

The arrangements for the Jubilee Celebration of the Institute are well in hand. The occasion will afford an exceptional opportunity for the reunion of old friends from all parts of the country. Representatives of many professional and scientific societies and institutions, and of the Local Sections of the Institute will be present. The members of the Committee of the London and South Eastern Counties Section will act as stewards. Over 1,250 guests are expected at the Conversazione to be held at the Wharncliffe Rooms on the evening of Wednesday, December 14. Members of the Institute and of allied chemical societies and institutions who have accepted the invitation extended to them by the President and Council and who have received tickets are asked to note that the President and Mrs. Smithells and the Council of the Institute will receive them from 7.30 p.m.

Over 1,000 tickets have been issued for seeing the films illustrating the British Industries, which will be shown by the courtesy of the Federation of British Industries and the Gaumont Company at the New Gallery Cinema, 123, Regent Street, on Thursday, December 15, from 10,30 a.m., to 12.30 p.m. Ticket holders will be admitted from 10 a.m., and are advised to be in their places in good time.

A large and distinguished company is expected at the Jubilee Dinner which is to be held at the Wharncliffe Rooms on Thursday, December 15, at 7 for 7.30 p.m. Guests are advised to arrive in good time.

On Wednesday, December 14, and Thursday, December 15, at the Institute's headquarters, 30, Russell Square, documents and portraits of historical interest, particularly in connection with the foundation of the Institute, will be exhibited. In addition, Mr. George H. Gabb, has kindly promised to lend a number of very interesting documents and apparatus relating to Joseph Priestley; Mr. Cecil H. Cribb has kindly promised to lend a selection of prints and other exhibits of interest to chemists; and the Institute's collection of lantern slides, illustration the history of chemistry, will be displayed.

On Thursday, December 15, the Masters and Wardens of the Worshipful Company of Salters, in honour of the occasion, will entertain to luncheon, at Salters' Hall, the President, Officers and Council of the Institute and the representatives of many societies.

BOARD OF TRADE ANNOUNCEMENT.

Safeguarding of Key Industries.

The Treasury have made an Order under Section 10(5) of the Finance Act, 1926, exempting the following articles from Key Industry duty from 28 November, 1927, to 31 December, 1928 :— Bromural (Dormigene); Eukodal; Lithium carbonate; Lithium hydroxide; Nickel hydroxide; Papaverine; R. Potassium permanganate; Quinine ethyl-carbonate; Resorcine (Resorcinol); and Styracol (Guaiacol cinnamate).

The Treasury Order will be published shortly.

GELATINE NOT A FOODSTUFF.

Declaration by the Board of Trade.

Whereas by Sub-section (1) of Section 10 of the Merchandise Marks Act, 1926 (16 & 17 Geo. V. c. 53), it is provided that for the purposes of the said Act, unless the context otherwise requires, the expression "agricultural and horticultural produce and the produce of any fishing industry" includes all foodstuffs other than such foodstuffs as the Board of Trade (hereinafter called the Board) with the concurrence of the Minister of Agriculture and Fisheries may declare not to be foodstuffs for the purposes of this definition :

And whereas the Minister of Agriculture and Fisheries has concurred in a proposal of the Board to declare gelatine not to be a foodstuff for the purposes of the said definition :

Now therefore the Board, with the concurrence of the Minister of Agriculture and Fisheries, hereby declare edible gelatine not to be a foodstuff for the purposes of the aforesaid definition.

UNION OF EUROPEAN FLAX PRODUCERS.

According to a report in the *Prager Presse*, which has been forwarded from the British Commercial Secretary's office at

slovak Central Flax Producers' organisation with regard to a Union of Flax Producers of the whole of Europe on questions of common procedure in the protection of their interests is meeting with success, and it is to be assumed that the negotiations in this matter which have hitherto been only preparatory will be brought to a successful conclusion within one year. Negotiations have already been carried out with some states which are entirely in agreement with the idea, in which connection it may be specially emphasised that Soviet Russia is in agreement with this action and places great importance on the question of a Union of European Flax Producers.

GERMAN POTASH INDUSTRY.

The British Commercial Secretaries at Berlin state that although in 1926 the very favourable results achieved in the German potash industry during 1925 were not attained, and sales showed a diminution of some 125,000 tons to 1,100,000 tons, they far exceeded the 1924 sales of 843,860 tons. It is true that German inland sales, which account for nearly 60 per cent. of production, showed a reduction in 1926, but this would seem to be counterbalanced by increased sales during the first quarter of this year, largely attributable to the mild weather. Foreign sales did not develop to the extent which had been hoped, but were doubtless in some measure temporarily influenced by the change in the foreign sales organisation consequent upon the conclusion of the Franco-German Potash Agreement. Foreign sales are now undertaken conjointly by the German Potash Syndicate and the Société Commerciale des Potasses d'Alsace.

THE HARDWARE TRADE OF CANADA.

The population of Canada, which is steadily growing, is now nearly 9,500,000, and its annual consumption of metals and metal goods is valued at about 280 million dollars, inclusive of automobiles and parts thereof, machinery and other heavy lines, the value of goods imported by the wholesale and retail hardware trade probably being about 20 million dollars only. This business is largely in the hands of American manufacturers, who often regard Canada as part of their home market, especially as it takes goods of design similar to those used in the United States.

THE BRITISH EXPORTERS' COMPETITORS.

Although hardware imports into Canada have grown during the last three years, the figures for the iron and steel group being 134,684,000 dols. in 1924-25, 18,197,000 dols. in 1926-27, the British share of the trade has dwindled, 13.2, 9.9 and 6.6 being the respective percentages.

As stated above, competition in the import trade comes mainly from American manufacturers, but Canada herself is increasingly producing such goods.

GENERAL INDUSTRIAL RESEARCH.

In order to provide a co-ordinated body for determining the lines of General Industrial Research, Imperial Chemical Industries Limited have established a Research Council which held its first meeting on Thursday. The Research Council will be presided over by Sir Alfred Mond, Chairman of the Company, and the other members will be Dr. G. C. Clayton, M.P., Col. G. P. Pollitt and Mr. J. Rogers (Directors), Major F. A. Freeth, F.R.S., Dr. E. F. Armstrong, F.R.S., Dr. R. E. Slade, Mr. H. A. Humphrey and Sir Frederick Keeble, F.R.S., all of whom are associated with Imperial Chemical Industriesfi Ltd., or its subsidiary companies; Prof. F. G. Donnan, F.R.S. (Professor of General Chemistry, University College, London), Prof. Robert Robinson, F.R.S. (Professor of Organic Chemistry, University of Manchester), Prof. W. A. Bone, F.R.S. (Chief Professor of Chemical Technology, Imperial College of Science), Prof. F. A. Lindemann, F.R.S. (Professor of Experimental Philosophy, Oxford), and Dr. E. K. Rideal (Lecturer in Physical Chemistry, Cambridge). Major A. E. Hodgkin will be Secretary.

The Company has felt that co-ordinated Industrial Research in Britain has suffered in the past from lack of a sufficiently close association with the academic and scientific worlds. The main function of the Research Council will be advisory and it will act as a clearing house for ideas. Steps have also been taken for following up in the most energetic manner all promising matters which may come before the Council. The Council will provide close liaison between Industry and the Universities and will promote both long distance scientific industrial research and research of the so-called purely academic type.

This is the first body of its kind to be established in this country, though similar organisations have been of great service to

both science and industry in other countries. The objective is to place British practice upon more than competitive terms with modern achievements and organisations elsewhere. It is felt that by such means Britain may retain her supremacy among the industrial nations of the world.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.

PHYSICAL AND CHEMICAL SURVEY OF THE NATIONAL COAL RESOURCES.

LANCASHIRE AND CHESHIRE SURVEY COMMITTEE.

The Physical and Chemical Survey of the National Coal Resources is one of the main aspects of the Fuel Research work of the Department of Scientific and Industrial Research. In pursuance of the Department's policy of carrying out the work by means of local committees appointed in coal areas to advise upon the course of work in those areas, the first committee to be appointed was one to deal with the coalfield of Lancashire and Cheshire. In this area there already existed a research association formed by a number of colliery companies, and known as the Lancashire and Cheshire Coal Research Association. An arrangement was made whereby the Association agreed to carry out the work and to appoint, for its direction, a special Executive Committee including representatives of the Fuel Research Board and the Geological Survey of Great Britain.

This Committee has recently been enlarged in order that it should be representative of the whole coalfield.

Committees are also actively at work in the following areas :—Durham and Northumberland, South Yorkshire, Nottinghamshire and Derbyshire, and North Staffordshire. Another committee is dealing with the coalfields of Scotland.

PRODUCTION OF BRASS AND COPPER PRODUCTS IN CANADA INCREASING.

According to a statement issued by the Dominion Bureau of Statistics at Ottawa, the production in 1926 of the brass and copper products industry in Canada reached a total figure of $22,028,686 in 1926. This output was 15 per cent. over the value of $19,155,309 reported for 1925 and considerably higher than in any previous year.

Of the 98 plants reporting to this industry, 64 were located in Ontario, 19 in Quebec, 8 in British Columbia, 3 in Manitoba, 2 in Nova Scotia, and 1 each in New Brunswick and Alberta. These concerns represented a capital investment in Canada of $20,764,404, employed each month an average of 4,533 people whose earnings for the year totalled $5,716,529, and by manufacturing processes added $10,217,950 to the value of purchased materials which cost $11,810,686.

BRITISH IRON AND STEEL.

There was an increase of 4,800 tons in the production of pig-iron during October as compared with September and two more furnaces were in blast at the end of the month. The output of steel ingots and castings showed a heavy reduction, but was still above that of August and of July.

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

The following papers were read at the meeting held on Thursday, November 17, 1927 :—

Absence of a Linear Relationship between Graded Simple Reflex Flexions and the Relations thereof evoked by a Constant Extension Producing Stimulus. By T. GRAHAM BROWN, F.R.S.

1. In decerebrate cats, graded flexion magnitudes of simple flexor shortening are obtained in response to flexion-producing stimuli of different intensities. Each of these simple shortenings is then subjected to the " inhibitory " effect of a constant extension-producing stimulus—thus giving componnd flexor shortening.

2. Comparison of the magnitudes of simple flexor shortening and of compound flexor shortening fails to establish a linear relationship between the two.

Absence of a Linear Relationship between the Reflex Flexor Shortenings evoked by a Graded Series of Flexion-producing Stimuli and the " Inhibitory " Lengthenings of a Constant Extension Reflex evoked by the same Stimuli. By T. GRAHAM BROWN, F.R.S.

1. In decerebrate cats, graded reflex magnitudes of simple flexor shortenings are obtained in response to flexion-producing stimuli of different intensities. Each of those stimuli is then compounded with a constant extension-producing stimulus, and the resultant lengthening (relaxation) of the extensor muscle is measured.

2. Comparison of the magnitude of simple flexor shortening and of compound extensor lengthening fails to establish a general linear relationship between the two.

The Relation of the Magnitudes of Remaining Reflex Shortening in Two Antagonistic Muscles during Compound Stimulation. By T. GRAHAM BROWN, F.R.S.

1. Where two antagonistic reflex stimuli are applied concurrently, the remaining shortenings of two antagonistic muscles during compound stimulation are related to each other.

2. This relation is such that in many cases where one or both of the reflex stimuli are varied in intensity, the sum of the remaining shortenings in the two antagonistic muscles (each measured as a ratio to maximal reflex shortening) is constant.

3. In other instances this constancy fails, but a series of sums bears an approximate relationship of linearity to the magnitudes of the simple reflex shortenings evoked by the series of graded reflex stimuli which are used in the experiments. The most general statement of this relationship of sum is as follows: The sum of the *proportional remaining shortenings in two antagonistic muscles*, Y, is linearly related to the simple reflex shortening, X, evoked at each intensity of the series of graded reflex stimuli used in a series of compound reflexes, *i.e.*, $Y = AX + B$.

4. This relationship of the remaining shortenings in two antagonistic muscles during compound reflex stimulation appears to be a more fundamental one than the "reciprocal" reflex relationship between shortening in one muscle and inhibitory lengthening (relaxation) in its antagonist.

5. Notwithstanding the generality of these conclusions, exceptions to the linear relationship occur.

Responses to Stimulation of the Motor Area of the Cerebral Cortex. By SYBIL COOPER AND D. DENNY-BROWN. Communicated by Sir Charles Sherrington, F.R.S.

1. The spinal discharge evoked by cortical stimulation can follow the rate of repetition of break shocks in that stimulus up to about 180 a second, indicating a very simple synaptic relation between the pyramidal tract and the anterior horn cell.

2. Rates of stimulus above and below that rate usually cause a total electromyographic rhythm of 160 to 180 a second.

3. Varying types of grouping of the spinal discharge occur, among them being that of a "dominant" rhythm of 35 to 50 a second, with no relationship to the rate of stimulus.

4. The power of summation of the cortico-spinal path is well illustrated by the relative constancy of the summation period. The comparative stability of that period gives it especial value in investigating some aspects of cortical excitability.

5. The typical motor response to stimulation of the motor area shows signs of concurrent inhibition. Reasons are given for believing that clonic after-discharge, "epilepsy," and the form of the motor response are the result of a conflict betweer inhibition and excitation.

THE CHEMICAL SOCIETY.

Papers read on Thursday, December 1:—

Action of Beckmann's Chromic Acid Mixture on some Monocyclic Terpenes. By T. A. HENRY AND H. PAGET.

The action of chromic acid, under similar conditions, on α-terpinene, *l*-limonene and α-phellandrene was examined. α-Terpinene is known to be oxidised mainly to dimethylacetonylacetone, only traces of αδ-dihydroxy-α-methyl-δ-*iso*propyladipic acid being formed. *l*-Limonene is converted into 1 : 2 : 8-trioxyterpan and a keto-lactone, $C_{10}H_{16}O_3$, both of which have already been obtained by Wallach by the oxidation of terpineol, so that the latter appears to be the first product of the action of chromic acid on limonene.

α-Phellandrene is oxidised to two keta-lactones, $C_{10}H_{16}O_3$, and $C_9H_{14}O_3$, for which constitutional formulæ are suggested, *iso*-propylsuccinic acid, thymoquinol, and thymoquinone; the disemicarbazone of the latter has been obtained for the first time in two stable yellow modifications and one colourless labile form.

The Condensation of Glyoxalines with Formaldehyde. By R. GRINDLEY AND F. L. PYMAN.

A study of the condensation with formaldehyde of several derivatives of glyoxaline containing various substituents shows:—(1) that glyoxalines containing a free imino-group yield 4(5)-hydroxymethyl derivatives, (2) that N-methylglyoxalines yield either 2- or 5-hydroxymethyl derivatives, (3) that no condensation products of nitroglyoxalines with formaldehyde could be isolated.

Glyoxaline-4(5)-formaldehyde. By W. HUBBALL AND F. L. PYMAN.

Methylation of glyoxaline-4(5)-formalde, its 5(4)-methyl-homologue and methyl glyoxaline-4(5)-carboxylate shows that the carbonyl group behaves like the nitro-group in directing the formation predominantly of substances in which the carbonyl and methyl groups are in the 5 : 1-position.

Studies of Dynamic Isomerism. Consecutive Changes in the Mutarotation of Galactose. By G. F. SMITH AND T. M. LOWRY.

The mutarotation of galactose, unlike that of glucose, does not conform even approximately to the unimolecular law, since the unimolecular velocity coefficient decreases by at least 50 per cent. during the course of the action. Since the magnitude of the coefficient is independent of the concentration of the sugar the action cannot be multimolecular, but must be interpreted as depending on two or more consecutive unimolecular changes.

Triazole Compounds. Methylation of Some 1-Hydroxy-1 : 2 : 3-Benztriazoles. By O. L. BRADY AND C. V. REYNOLDS.

The methylation of 1-hydroxy-1 : 2 : 3-benztriazole and of 1-hydroxy-6-methyl-1 : 2 : 3-benztriazole gives a larger proportion of N- to O-methyl derivative than does the methylation of the more strongly acidic nitro- hydroxy-benztriazoles previously studied. It seems that the alkylation of these compaunds is analogous to that of the oximes, and that the O-methyl derivative is formed by an ionic and the N-methyl drivative by a molecular reaction.

The Reaction between Diaryloxyisopropyl Alcohols and Phosphorus Oxychloride in the Presence of Pyridine. By D. R. BOYD AND D. E. LADHAMS.

When di-*p*-tolyloxy*iso*propyl alcohol reacts at 0° with excess of phosphorus oxychloride in the presence of pyridine, the product obtained, on treating the reaction mixture with ice, is chiefly di-*p*-tolyloxy-*iso*propyl phosphate $(C_7H_7.O.CH_2)_2CH.O.PO(OH)_2$, but if the reaction mixture is heated at 100° before decomposing with ice, di-*p*-tolyloxy*iso*propyl chloride is formed, together with a comparatively small amount of the corresponding pyridinium salt, $C_5H_5N,CH(CH_2.O.C_7H_7)_2,Cl$. Similar results have been obtained with other diarylyxy*iso*propyl alcohols. Pyridine forms with phosphorus oxychloride a crystalline additive compound $(C_5H_5N)_3,POCl_3$. An explanation of these observations is offered.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

Composition of Cracked Distillates. By PROF. J. S. S. BRAME, F.I.C., F.C.S. (Member), AND T. G. HUNTER, A.I.C.

Although the physical and engineering side of the cracking process has developed rapidly within the last few years, the chemical nature of the product has been but partially investigated. Attention has been drawn to this in the Annual Report of the Progress of Naphthology for 1924, in the following comments.

" Very little is known about the chemical composition of the initial charging stocks which are used in cracking, and about as much is known of the final products, while the intermediate reactions are only guessed at."

The classical researches of Thorpe and Young (*Proc. Roy. Soc.*, 1873, 184), have shown that the pyrolytic decomposition of paraffins under pressure is essentially a simple symmetrical splitting of the chain into a lower paraffin and the corresponding olefine. On the other hand, however, the behaviour of napththenes on pyrolysis is quite unknown.

Engler and his collaborators have demonstrated that the majority of cracked distillates contain all the four general classes of hydrocarbons, unsaturateds, aromatics, naphthenes, and paraffins. The difficulty of ascertaining the composition of such highly complex mixtures arises largely through the lack of satisfactory methods for the isolation of these different classes of hydrocarbons, and the separation of individual compounds. Even the estimation of unsaturated hydrocarbons, in bulk, and the aromatic hydrocarbons in conjunction with the unsaturateds is still in an unsatisfactory state.

The present research was undertaken primarily with the object of investigating possible methods of dealing with this problem and applying them, even in an admittedly incompletely developed stage, to the examination of a cracked spirit.

Cracked spirit is sharply distinguished from straight run petrol in its high content of unsaturated hydrocarbons. Since recent work has indicated its freedom from the tendency to detonate in the engine, it now commands a higher price than ordinary petrol. The only disadvantage attendant on its use is the formation of sticky yellow gums, which separate in storage, and are partly dissolved in the spirit and colour it

yellow, and are liable to cause trouble in the engine. This property of gumming is usually ascribed to chemical changes, chiefly oxidation, in the di-olefines, but up to the present hydrocarbons of this type have not been separated from cracked spirit, although Armstrong and Miller isolated a derivative of butadiene in the liquid condensate from *Pintsch oil gas.*

Part 1 of this paper is devoted to the investigation of the methods of separating unsaturated and aromatic hydrocarbons from the saturated paraffins and naphthenes, and the much more difficult problem of finding some method applicable to the separation of these two latter classes. Whilst this problem has not been solved completely, a method of obtaining a reasonably high degree of separation has been developed, and it was felt that the methods were sufficiently perfected to warrant their application to a commercial cracked spirit obtained from Russian kerosine in a Cross chacking plant.

COHESION AT SOLDERED SURFACES.

By T. B. Crow (*Jamshedpur, India*).
(*Faraday Society, November 23, 1927.*)

A piece of metal with a soldered joint in its middle may be considered (in regard to its cohesion as measured by mechanical tests), from two aspects, namely (1) as one compound piece of metal capable of resisting, as a whole, a certain stress, and (2) as a composite material (consisting of at least two *macroscopically* distinct members), whose breaking strength must be compared with the respective tenacities of the two constitnent members. What will be the strength of a join, considered as a simple test piece, in terms of the strength of the solder in it? The ability of a soldered join to withstand of itself rupture by a tensile force is evidently dependent upon the capacity of the solder to form a waist, *i.e.*, to flow: a possibility closely connected with the surface tensions operating at the interfaces with the copper. The same thing, of course, is true if a test bar be groved; such a bar will "pull higher" than one of the same material not similarly grooved. Will fracture take place in the body-metal, in the solder, or at an interface? Is there an interface, or does penetration of solder into body-metal or *vice versa* occur, so as to render definition poor or non-existent? What will be the variation of strength of a join with varying thickness of solder film, or with varying soldering temperatures, or with and without the application of pressure during joining? I found that, with electrolytic copper rods and solder of eutectic composition :—

(1) Decrease of gap width increased the tensile strength up to a maximum of about 14 tons/inch; after which further decrease in gap width (obtained by the agency of pressure), corresponded with a falling off in strength. In all these cases the solder used, when tested *as solder*, had a tensile strength of about 4 tons per sq. inch.

(2) The highest ultimate load of a join was always below the yield point of the copper.

(3) Elongation and yield points were observed only in those joins where there was a considerable thickness of solder in the gap; when the gap was 5.1 mm. (on a test piece having diameter of $\frac{3}{16}$ in.) the test bar broke at a load about equal to that of ordinary eutectic solder.

(4) There was a certain temperature of soldering which gave a maximum strength, above which it rapidly fell off to about $\frac{1}{3}$ of the maximum value.

(5) The microstructure of joins showed (*a*) the presence of an interfacial layer of copper-tin alloy (which is believed to correspond to Heycock and Neville's "H" constituent), between the copper and the solder, and (b) in joins made a higher temperature the development of a second phase, η, which appeared between the "H" and the mass of unchanged copper.

One question to which attention should be drawn is the possibility of the use of different soldering flucs giving nse to joins of different strengths—other things being equal. The subject is to big to be detailed here, but what is wanted in this connection is some consideration of the properties of the actual surfaces of solderable metals when in a condition to "take" the solder. The behaviour of molten solder in contact with a solid metal is a particular instance of the general phenomena accompanying the contact of a liquid on a solid surface (and this solid surface, in the case of a metal aboiut to be soldered, is in a certain condition, due to the action of a flux); the actual condition and molecular distribution of the applied solder or intermediary alloys a few molecules thick in the immediate region of the original body-metal surface (*i.e.*, what actually exists in the interfacial region, and how it got there) must be studied in the light of recent work of physicists on such questions as adsorption, activated surfaces, the nature of surfaces, etc., as instanced by

the work of Deacaux, Langmuir, Harkins, Harkins and Cheng, Bosanquet and Hartley, aud others.

SUMMARY.

Whatever the nature of cohesion and adhesion, the case of a soldered join (or, for that matter, many forms of joining or sticking phenomena) presents an exceedingly complicated instance of their action. In order to study cohesion and adhesion problems in joins, etc. it is necessary to find such a meaning to those terms as will enable them to be applied quantitatively to layers or films of materials which, in certain cases, might only be, at most a few molecules thick, and which were possibly in contact with other similar layers of different composition.

INSTITUTE OF METALS.

Derby, September 6-9, 1927.

The Constitution and Physical Properties of some of the Alloys of Copper, Zinc, and Cadmium. By C. H. M. JENKINS, B.Sc., A.R.S.M.

The constitution of the copper-zinc-cadmium alloys has been studied, and the physical properties of the two most commonly used brasses containing small proportions of cadmium investigated.

The study shows a complex constitution in the range of the ternary system where the copper content exceeds 45 per cent. and the cadmium content is less than 10 per cent. The solid solubility of cadmium in α brass diminishes with increasing proportions of zinc from a maximum value of 2.7 per cent. Cadmium present beyond the proportion retained in solid solution is found to occur as the binary constituent, Cu_2Cd. The alloys whose constituents are α brass and more than a trace of Cu_2Cd commence to melt at comparatively low temperatures between 549° and 614°. Traces of free Cu_2Cd on heating dissolve in the α phase without melting, owing to the slightly increased solubility at higher temperatures.

A peritectic reaction, in which the β phase of the Cu-Zn system reacts with liquid to form the α phase and Cu_2Cd, occurs in this system at 614° C., considerably affecting the properties of the alloys. This reaction is primarily due to the result of the two peritectic reactions found in the binary copper-zinc and copper-cadmium alloys, at 906° and 549° C. ,respectively.

The effect of cadmium on β brass is noticeable in a different manner. This phase shows a greatly increased solid solubility for cadmium with increase of temperature reaching a maximum value at 8 per cent. At low temperatures the γ constituent to have a greater power than the β phase of retaining cadmium in solid solution.

The effect of cadmium on the physical properties of 70 : 30 and 60 : 40 brass has been studied by the use of cadmium-bearing zinc containing proportions of cadmium decidedly in excess of those likely to be encountered in retort zinc. The results show that the greater proportion of the cadmium content of the zinc is retained in the brass and is not lost by oxidation or volatilisation during melting. The presence of less than 0.2 per cent. of cadmium seems to prevent the hot-rolling of 70 : 30 brass and cadmium, and of more than 0.5 per cent. to increase to a slight extent the liability to unsoundness in cast material.

The general results indicate that the use of cadmium-bearing zinc does not produce any marked alteration in the physical properties of the brass. Additions of cadmium up to 1 per cent. by weight cause an improvement in the tensile strength, generally accompanied by a reduction in elongation. The effect is most noticeable in the cast 70 : 30 brass, and is less pronounced in worked material.

The Protection of Aluminium and its Alloys against Corrosion. By H. SUTTON, M.Sc., AND A. J. SIDERY, Assoc. Met.

Some experiments are described in which samples of aluminium and aluminium alloys were treated by various protective processes, including anodic oxidation, zinc-, cadmium-, and nickel-plating. Certain practical features of the methods investigated and, also, the results of corrosion tests extending over periods of 1 to 2 years, are discussed. The resistance of aluminium, duralumin, and of certain other aluminium alloys to corrosion by sea-water is considerably increased by anodic oxidation and the subsequent applicatin of a grease, such as lanoline.

Electro-deposited coatings of zinc, 0.005 in. thick, afforded better protection to aluminium that did coatings of cadmium of similar thickness, but the two types of deposit appeared to give an approximately equal degree of protection when applied to alloys of aluminium. Unsatisfactory results were obtained from nickel deposits of normal thickness. Comparison is made between anodic oxidation and zinc- or cadmium-

plating as methods of protecting aluminium or aluminium alloy parts of aircraft.

The Nature of the Film Produced by Anodic Oxidation of Aluminium. By H. SUTTON, M.Sc., AND J. W. W. WILLSTROP, B.Sc., A.I.C.

A method of isolating the film from anodically treated aluminium is described. The metallic aluminium is volatilised in dry hydrogen chloride. The properties of the film so obtained are described, and the thicknesses of films obtained under various conditions have been calculated. The films isolated from treated commercial aluminium sheet are usually of a grey colour, due to traces of carbon left behind when the aluminium sublimes as chloride. The presence of elementary silicon in films produced on commercial aluminium is also shown. Films varying in thickness from 0.033μ to 2μ have been obtained, the thickness of the film produced by the usual standard treatment being about 1μ. From the volume of gas evolved by treated aluminium when heated *in vacuo* to 1200° C. the film is shown to consist of oxide and not of hydroxide.

Age-Hardening Tests with Elektron Alloys. By K. L. MEISSNER, Dr.Ing.

Six different Elektron alloys ,made up by the I. G. Farbenindustrie A.G. at Bitterfeld (Germany), were examined with respect to their capability of age-hardening by ageing at room temperature and at elevated temperatures up to 200° C., with different ageing periods of from 8 to 40 hours.

The System Magnesium-Cadmium. By WM. HUME-ROTHERY, M.A., Ph.D., AND S. W. ROWELL, B.A.

The equilibrinm diagram of the system magnesium-cadmium has been investigated by thermal and microscopic methods. The system is shown to contain a solid solution based on cadmium and denoted α, a definite intermetallic compound $MgCd^2$, and a solid solution in magnesium denoted β. The solid solution α extends from 0 to about 24 atomic per cent. magnesium at most temperatures. The compound $MgCd_2$ does not form any solid solutions, whilst the β solid solution extends from about 40 to 100 atomic per cent. magnesium.

The solidus and liquidus are shown not to meet at the composition 50 atomic per cent. as reported by earlier workers. The β-solid solution undergoes a transformation at temperatures about 200° to 250° C., but the maximum temperature of this change is at 54 atomic per cent., and not at 50 atomic per cent., as previously reported. This change is unaccompanied by any alteration in microstructure, and it has not been possible to obtain any two phase alloys in this region either by slow cooling or by quenching. It is suggested that the change is of the same nature as that of the β brasses.

It has been shown that prolonged annealin gis necessary to attain equilibrium in the solid alloys in the neighbourhood of the compound $MgCd_2$, and the principal differences between the present and the earlier work are due to the fact that the former investigators did not anneal their alloys for a sufficient time.

Cathodic Disintegration as a Method of Etching Specimens for Metallography. By CYRIL SMITH, B.Sc.

The well-known phenomenon of cathodic sputtering can be used to develop the structure of metal specimens for microscopic examination. Silver-copper alloys are particularly suited for etching by this process, which causes staining of the copper-rich constituent as well as removal of the silver.

EFFECT OF HYDROGEN-ION CONCENTRATION ON THE ABSORPTION OF PHOSPHORUS AND POTASSIUM BY WHEAT SEEDLINGS.

By JEHIEL DAVIDSON,

Associate Chemist, Crop Chemistry Laboratory, Bureau of Chemistry and Soils, United States Department of Agriculture.

INTRODUCTION.

Absorption by plants is controlled by two groups of factors, one affecting the availability of the material to be absorbed, and the other the absorbing power of the plants. Although the hydrogen-ion concentration of the medium may affect the solubility of the plant-food constituents, its effect on the absorbing power of the plant only was considered in the investigatins here reported. Its effect on growth received no attention.

SUMMARY.

Wheat seedlings were grown in potassium phosphate solutions of different initial hydrogen-ion concentrations.

Relatively more potassium than phosphorus was absorbed by the seedlings, irrespective of the initial hydrogen-ion concentration of the solution. In the solutions with initial hydrogen-ion concentration of

5.0 and lower this preferential absorption of potassium resulted in increased acidity. In solutions with initial hydrogen-ion concentrations of 6.0 and 7.0 the increase in acidity was but slight, owing to the buffer properties of the solutions.

More phosphorus was absorbed by the seedlings from the solutions with initial PH values of 5.0 and lower than from those with PH values of 6.0 and 7.0. As all potassium salts of phosphoric acid are soluble, this tends to show that the physiological availability of phosphorus depends upon the hydrogen-ion concentration of the medium.

The general character of the results was not affected by the duration of the experiments nor by the age of the seedlings. Neither was it affected by the concentration of the solution, provided the differences in initial reactions in the solutions of the lower concentrations were maintained by daily renewal.

The excess of phosphorus absorbed from the acid solutions was found in the tops of the seedlings. The tops also had a higher potassium content than those from the neutral solutions. The roots from the neutral solutions contained more phosphorus and almost twice as much potassium as those from the corresponding acid solutions.

The power of the seedlings to absorb phosphorus and potassium decreased as they advanced in age.

The absorption phenomena observed in these experiments, as well as the absorption of cations and anions by living cells in general, are explained by the assumption that there is a relatively wide range in the isoelectric points of individual protoplasmic ampholytes.

FORTHCOMING EVENTS.

INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, London.

Thursday, December 15, at 6 p.m.—"Squirrel-Cage Induction Motors." By D. B. Hoseason.

Mersey and N. Wales Section, at the Laboratories of Applied Electricity, Liverpool University."

Monday, December 12, at 7 p.m.—The 18th Kelvin Lecture, "High Frequency Currents." By Prof. E. W. Marchant, D.Sc,

North-Midland Centre, at the Hotel Metropole, Kings, Street, Leeds.

Tuesday, December 13, at 7.15 p.m.—"The Application of Electricity to Warships." By W. McClelland, C.B., O.B.E.

INSTITUTE OF METALS.

Scottish Local Section, at the Rooms of the Institute of Engineers, 39, Elmbank Crescent, Glasgow.

Monday, December 12, at 7.30 p.m.—"Age-Hardening Alloys." By Robert Hay, Ph.D.

Birmingham Local Centre, Engineers' Club, Waterloo Street, Birmingham.

Thursday, December 15, at 7 p.m.—"Duralumin." By L. Aitchison, D.Met., F.I.C.

INSTITUTION OF MINING AND METALLURGY.

225, City Road, London.

Thursday, December 15.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

Tuesday, December 13, at 5.30 p.m.—At Royal Society of Arts Building, John Street, Adelphi, London.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

36, George Street, Manchester.

Tuesday, December 13 at 5.30 p.m..

Chemical Section, Friday, December 16, at 7 p.m.

ROYAL INSTITUTION.

Albemarle Street, London.

Tuesday, December 13, at 5.15 p.m.—"A Year's Work of X-ray Crystal Analysis." By Sir William Bragg, K.B.E., Ll.D., F.R.S.

Thursday, December 15, at 5.15 p.m.—"Petroleum Natural Gases and their Derivatives." By James Kewley, M.A., F.I.C.

Saturday, December 17, at 3 p.m.—"Recent Developments in Astrophysics." By F. J. M. Stratton, M.A., D.S.O., D.L.

ROYAL SOCIETY OF ARTS.

John Street, Adelphi, London.

Wednesday, December 14, at 8 p.m.—(Ordinary Meeting).—Major Raymond G. Clements, M.C., M.Inst.C.E. : "Road Surfaces."

THE ROYAL INSTITUTE OF PUBLIC HEALTH.

37, Russell Square, London, W.C.1.

Wednesday, December 14, at 4 p.m.—"The Changed Conditions of Quarantine." By Prof. W. E. Hope, O.B.E., M.D., D.Sc., Prof. of Hygiene, University of Liverpool.

SOCIETY OF GLASS TECHNOLOGY.

A meeting will be held on Wednesday, December 14, at University College, Gower Street, London, W.C.1. Council meeting, 11 a.m.; special meeting at 2.30 p.m.; and ordinary meeting at 2.40 p.m. The following papers will be discussed:— "The Analysis of Opal Glasses." By J. H. Davidson, M.Sc., F.I.C., and Miss V. Dimbleby, M.Sc. "The Durability of Iron-Containing Glasses." By Miss V. Dimbleby, M.Sc., and Prof. W. E. S. Turner. "The Effect of Iron Oxide on the Properties of Glass." By S. English, D.Sc., H. W. Howes, M.Sc. Tech., and Prof. W. E. S. Turner.

UNIVERSITY COLLEGE.

Gower Street, London, W.C.1.

Monday, December 12, at 5.15 p.m.—"Seals, Mediæval and Modern." A public lecture by Mr. Hilary Jenkinson. (Lantern Illustrations).

Friday, December 16.—Faculties of Arts, Laws, Science, Medical Sciences and Engineering: First term ends.

Saturday, December 17.—Slade School of Fine Art: First Term ends.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

31,066.—I. G. Farbenindustrie Akt.-Ges.—Manufacture of orthocyanaryl thio-glycolic acids. November 18.

30,489.—Fuchs, O.—Utilising ethyl alcohol. November 14th.

31,053.—I. G. Farbenindustrie Akt.-Ges.—Manufacture of diacidyl-derivatives of naphthalene, etc. series. November 18th.

30,911.—Linch, F. W.—Preparing triarylmethane dyes. November 17tb.

30,940.—Scottish Dyes, Ltd.—Dyes and Dyeing. November 17th.

Specifications Published.

256,273.—I. G. Farbenindustrie Akt.-Ges. Process for protecting wool from damage by bacteria.

259,608.—I. G. Farbenindustrie Akt.-Ges.—Manufacture of derivatives of benzanthrone which contain sulphur.

260,969.—I. G. Farbenindustrie Akt.-Ges.—Process for the production of carbon disulphide from its elements.

268,726.—Allgemeine Ges. fur Chemische Industrie.—Purification of hydrocarbons and the like by liquid sulphur dioxide.

280,373.—British Dyestuffs Corporation, Ltd., Payman, J. B., and Hall, N. Aromatic acid anhydrides.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstracts Published.

277,769.—Treating waste acid liquors.—Klein, C. A., 7, Queen Annes Grove, Bush Hill Park, Enfield, and Brown, R. S., 36, Manor House, Marylebone Road, Both in London.

Barium sulphate.—Waste acid liquors containing sulphuric acid and, it may be, small amounts of iron salts, for instance, those obtained in the process for the preparation of titanium pigments described in Specification 243,081, after being decolorised, is necessary, as with animal charcoal, sulphur dioxide, or by producing a precipitate, *e.g.*, of barium sulphate, to carry down impurities in suspension, are treated with a barium compound such as the oxide or carbonate to obtain barium sulphate, the amount of the barium compound added being insufficient completely to neutralise the liquor, whereby a precipitate from from iron is obtained. To facilitate the reaction, a small quantity of an acid or soluble salt adapted to form a soluble barium salt may be added, for instance, hydrochloris, nitric, or acetic acid or their alkali salts.

278,112.—Benzanthrone derivatives. —Thomson, R. F., Thomas, J., and Scottish Dyes, Ltd., Earl's Road, Grangemouth.

Oxy- and alkoxybenzanthrone; dibenzanthrnyl; dibenzanthrone dyes.—The process of Specification 251,313, according to which a mixture of an oxybenzanthrone and a dibenzanthronyl is obtained by oxidising

benzanthrone in sulphuric acid solution, is modified by effecting the said oxidation at low temperatures such as 0° C. The dibenzanthronyl may be conerted by alkali fusion into a pure form of dibenzanthrone; the oxybenzanthrone may be alkylated and subsequently subjected to alkali fusion to obtain dialkyloxydibenzanthrones. According to an example benzanthrone is treated with a solution of manganese dioxide in concentrated sulphuric acid at 0° C. or lower temperature; the product is boiled with bisulphite and freed from oxybenzanthrone by caustic alkali and from any residual benzanthrone by means of acetone or benzene.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

CORNSTON.

483,769.—All goods in class 3 which includes chemical substances prepared for use in medicine and pharmacy.—Craine and Golson, 2, Manchester Street, Liverpool. November 23rd.

AQUAGEN.

484,835.—Chemical substances prepared for use in medicine and pharmacy.—Allen & Hanburys, Limited, Plough Court, 37, Lombard Street, London, E.C.3 November 23rd.

IMPLETOL.

485,146.—Chemical substances prepared for use in medicine and pharmacy.—Payer Products, Limited, 31 to 34, Basinghall Street, London, E.C.2. November 23rd.

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STELLAR ENERGY, RELATIVITY, GRAVITY, ÆTHER, PHOTO-ELECTRIC EFFECT.

By F. H. LORING.

I.

Astronomers and physicists and chemists interested in the physical side of chemistry have marvelled at the enormous amount of radiant energy given out by the Sun; and considering his long life, the sum total of such energy up to the present time has been a mystery indeed.

Contraction due to gravitational consolidation of the Sun's mass would give rise to heat, but not nearly enough.

Chemical action is quite insufficient.

Meteorites falling into the Sun would produce heat, but there is no evidence of such a phenomenon existing on a scale sufficient to account for any appreciable heat production in this way.

Radioactivity is more promising, but there is no spectroscopic evidence of predominating masses of known intensely-radioactive atoms present in the Sun.

Enormous pressure in parts well below the surface of the Sun, due to gravitational attraction in the Sun's mass might induce radioactivity in all kinds of atoms present, and thus account for the enormous radiation observed. This idea has been considered by physicists, but so far as the writer is aware, it is not regarded with special favour, though it may be a contributory cause.

The combining of hydrogen atoms or their nuclei to form helium atoms would afford a more powerful source of energy, since there appears to be a loss of mass, assuming this condensation to take place; but this sort of combination has never been accomplished by man. Attempts have been made, but the final results were negative.

Four hydrogen atoms when added give a mass slightly in excess of that of helium as it is now known, and if that excess disappears in the process, according to Einstein's theory of relativity, it would afford an enormous output of energy. Or, if the positive and negative electrons in the Sun combine so as to occupy the same place at the same time *i.e.*, completely neutralise each other—according to prevailing ideas, both the mass of the proton (which is the positive electron) and the mass of the negative electron would disappear, and in its place, or in their common place, a radiation would be generated of such comparatively great magnitude, that this process might afford ample energy for explaining the great temperatures of stars—particularly large stars. In fact, granting this action, more than enough energy would be available, since there are enormous quantities of protons and electrons to draw from.

There is indirect astronomical evidence that the formation of helium, and consequently other elements, by the process above sketched, actually does take place. At least this theory fits in with observed peculiarities of certain classes of stars. The present views of astronomers and physicists seem to favour this idea, or the one following it, above, whereby the complete union mentioned causes mass to disappear, becoming transformed into pure radiation. Mass + energy = constant = the conservation of the constant, so to speak.

According to this view, it would not suffice to say "*the conservation of mass*"; or, on the other hand, to say "*the conservation of energy*"; for, *neither* would be conserved, but *their sum would be constant*. This has been a very attractive idea for advanced physicists and astronomers, and it is borne out by the theory of relativity, from which it originated. He who dares to assail the theory of relativity to-day dares much.

Still, all, or a few of, these phenomena may be taking place in some degree, and yet not represent the main source of heat.

Is there any other source of heat possible?

The photo-electric effect involves the mysterious *appearance* of more energy than can be obtained from the radiation that produces this effect. This excess of energy has not been experimentally accounted for. If, however, it is derived from the latent energy possibly resident in all space, as suggested by the present writer in the *Chemical News*, of November 4, 1927, then there *is* another source of energy to consider.

The lower temperature of the Sun-spots leads to the idea that the heat of the Sun is largely a surface process and this would harmonise with the photo-electric effect which is virtually a surface phenomenon.

The action of the Sun would then be something like this: Starting with considerable internal heat there would be a sort of gaseous or electronic bombardment of the vapour clouds round the Sun, producing there light of sufficient intensity and short enough wave-length to liberate electrons from the atoms forming the clouds. This being a photo-electric effect, on the view advanced, so that the energy gained would go on increasing up to a certain equilibrium point, and as the surface of the Sun is large there would be ample space available round it to tap the universal reservoir of energy. With a large efflux of electrons some form of atomic or sub-atomic combination might ensue which would produce more heat.

This seems a fantastic picture, but it is no more fantastic than Einstein's theory appeared when it first became known, and like this famous theory the idea here suggested is based upon a small effect observable in the laboratory.

Assuming such an effect operating on a large scale in the Sun and other stars, would it throw any light on the phenomenon of radio-activity?

It is only the massive atoms that are properly radio-active; and, as is well-known, atoms are made up mostly of space.

Do these massive atoms imitate the process here sketched as applied to the Sun and stars? If they do, then the atomic energy is only seemingly atomic and the real energy comes from space. Why then should the *nucleus* be concerned in this phenomenon? This fact seems contrary to the trend of the above argument, yet somehow there is a possible parallel. It should be noted in this connection that both in the radio-atom and probably in the Sun there is an inner or nuclear activity. Perhaps here lies the key that will unlock the door which brings the latent energy of space into kinetic being so to speak. There is much atomic space round the nucleus of every atom.

That the whole of space everywhere is a seat of energy in some diffused latent form is supported by the phenomena of gravity and electrical attraction, including its magnetic form, and even including electrostatic repulsion, if it may be so stated.

If the attraction and repulsion, or the + and - lines of force, are compounded, then, May not there be a 'residual' which is gravity? This idea will not do, because gravity involves mass, whilst the electrostatic field whether apparent or neutralised involves *surface* charge. Magnetic lines of force would work better, because magnetism is deep seated, but even in this case there is no mass quantity that would give a satisfactory equivalent. The idea here rests not so much on the iron of the magnet, say, or the surface of the condenser, but on the phenomenon in the air-gap or vacuum-gap.

Consider another class of phenomenon.

Taking a homely illustration, on the surface of a large cup of tea, or cup of coffee bubbles near to one another, but well away from the side of the cup, are often seen to move towards each other, as if gravitationally attracted, their speed of approach increasing until the bubbles meet. This is, of course, a well-known surface-tension effect, and there is no particular mystery about it.

In space, however, there is no surface in the common meaning of the term. Here an error may arise from ignorance, for if lines of force in the electric or magnetic sense are accepted, then these lines surely must represent something akin to the surface tension of the liquid.

Again, take another phenomenon. If a glass tube is just slightly scratched at one

point, in the manner done by glass blowers, and a red-hot blob of glass applied to the scratch the tube is easily broken off squarely. Consider the scratch an incipient line of force. The glass has no particular tendency to break until the so-called line of force is extended by the application of heat, which sets up a line of strain or break down in the glass. Most of the energy probably comes from the glass tube, and this is the main point here.

These are mechanical or physical properties of solids and liquids (see above). Now passing to the æther it must contain an energy strain that can be localised as in these experiments (see photo-electric effect).

The choice of language is difficult just here, but from that which follows it should convey some ideas not entirely meaningless.

II.

The principle of relativity rests on what is considered to be the cardinal fact of observation: that whatever experiments are made, whether optical, electrical, or mechanical, they are in no way influenced by the ensemble* participating in any uniform rectilinear motion.

Optical experiments or measurements could be performed within a very fast-moving railway train on a perfectly straight track without the slightest difference in the result as compared with those obtained within the train when at rest, assuming no subsidiary conditions, such as vibration or variation in speed. Watches would keep quite as exact time on such a uniformly-moving train as when as rest. In fact all the laws of nature go on just the same regardless if how fast the solar system is drifting through space. The planetary movements round the Sun are not relatively changed one iota by this drift—at least, not so fas as known.

The famous Michelson-Morley experiment was devised to detect the effect of drift on the passage of light to and fro in a system consisting of mirrors and a transmitting and reflecting plate, the apparatus with its observer partaking of the Earth's motion; but, no effect could be detected which would invalidate the opening statement of this section of the article.

This might be expressed ideally in another way, which, so far as present knowledge allows, comes to the same thing. If it were possible to measure the velocity of light as from one mountain to another, then back again, and compare the two measurements, they would, on the principle of relativity, agree; for, there would be no correction required due to the velocity of the Earth in its orbit round the Sun, assuming the mountains to be most favourably situated at the time for the test; that is to say, on a line parallel with the Earth's path of orbital movement.* This feature from the point of view of the æther will be taken up again below.

The *general* relativity rests on the fact by deduction, that the acceleration of gravity—rate of change in velocity of falling bodies—can be imitated by carrying out experiments within an accelerating lift or elevator so that no difference in the results follow. Here gravity is exactly imitated by the *acceleration* of the cage or car of the lift—and of course the apparatus and the observer within it. Gravity is, therefore, by inference, *not a force*.

This leads to the abolition of a *force acting directly from one body to anther* as expounded by Newton; and in its place the idea of an equivalent *field* is postulated, this being equivalent to the *acceleration*;† and going further the planets describe orbits, not because they are being constantly pulled towards the Sun by a force that balances their centrifugal, or outward straight-line tendency, but because this field governs their path which is the particular one most natural under the cir-

* Apparatus, observer, etc.

* It might be said that the velocity of light involved two terms, and however measured their sum was constant, as in the case of mass and energy (see section I). The idea that c is a spreading constant, involving two terms may afford some suggestive assistance here (see *Chemical News*, Nov. 18 and 25, 1927), but no clear and concise statement on this matter can be yet made.

† In order not to break the continuity of the argument a branch statement may be put in here. It is common knowledge that all bodies fall with the same velocity in a vacuum, *i.e.*, they suffer the same acceleration whether light or heavy. This elementary fact is in conformity with the gravitational-field idea just stated, and it strengthens the argument.

cumstance; just as a body away from all planets or suns (stars) would move in a straight line when once set in motion. It could obviously move in no other direction, rotation not being considered here.

That such a body should move even in a straight line is really a mystery, but only apparently simple to consider compared with the case of a body moving in a circle; in fact, all ultimate considerations are beyond the mind's comprehension. Matters of everyday experience lose their mystery, but they will not, as a rule bear the question WHY?

It is needless to say that the mathematical treatment, as fully developed by Einstein, fits the facts above stated; and this treatment accounts for such diverse phenomena as: (1) The slight deviation of light rays, from a distant star, when passing close to the Sun*: (2) the abnormal swinging round of the elliptical orbit of the planet Mercury; (3) the displacement of the spectral lines towards the longer wave-length side of the spectrum by gravitational fields stronger than that of the Earth. This was also predicted by the theory. In other words, atoms emit a lower-frequency radiation under the influence of a greater gravitational potential. Moreover, the theory of relativity has been applied with success to certain phenomena observed in connection with atomic structure. To be specific, the increase in mass of electrons issuing—at speeds near that of light in this case—from radio-atoms, with the consequent deviation expected from this theory when the electrons are subjected to the influence of electric and magnetic fields; and, in the case of spectral lines, the observed fine-line structure appears to be due to a relativity effect, which has been formulated by Sommerfeld, and confirmed experimentally by Paschen. This is all very well known and hardly needs repeating here.

Going back to the drift experiments, the results obtained by both theory and practice have made it convenient to abolish the æther from physics. That waves of light have their seat in such a real æther is still held by many, so that while the problem seems mathematically solved, there is the paramount difficulty of the æther. This æther has been called the bugbear of the physicists. It appears not to exist in so far as there is no drift effect due to any relative motion as stated above.

* This was predicted by Einstein's theory as is generally known.

Physicists seemingly are able to dispense with it, and there is no experimental evidence which *directly* proves its presence, but the evidence of its existence by analogy is overwhelming. Sir Oliver Lodge is a great exponent of the æther, as is well known.

If there is no æther the alternative seems to be that of a *void;* but the mind is not able to grasp such a void in which the whole mechanism of propagated energy as radiation takes place. Gravity, magnetic and electric fields are seen to turn this so-called void to useful account. Nodes in electromagnetic waves (Hertz) can be marked off in this void.

This phase of science is thus quite dramatically interesting, particularly to those who have mastered its main features.

III.

At the 1927 meeting of the British Association at Leeds, Prof. Whittaker, in his presidential address before the mathematical and physical sections, discussed some of the outstanding problems of relativity.

Now that the excitement about this great subject is over, and workers have settled down to probe deeper into the mysteries of nature, we may expect any day to hear of something which will make relativity more interesting than it is, and that is saying a good deal.

Prof. Whittaker goes to the root of matters, and the first striking statement is a quotation from FitzGerald's "Scientific Writings," page 313, that "Gravity is probably due to a change of structure of the æther, produced by the presence of matter."

It appears that Wiechert and those following him advocate the idea that Einstein's gravitational potential is in reality the inductive capacity and permeability of the æther as effected by and modified by the presence of ponderable matter.

Here is something worth thinking about. It is true that there is no magnetic or electrostatic field round matter except by special excitement, and such fields seem in no way connected with gravity ,though the laws of magnetic and electrostatic fields are the same as those of the gravitational field, at least are parallel in part. *Inverse square* and the *velocity of propagation* are the *laws* that have a common application. It should be observed that relativity is all comprehensive in these matters, so that, for example, the expression *electromagnetic mass* becomes by relativity a term of general application and cancels out, no longer being of specific application.

While the atom is internally an electrical system it conceals this fact in its gravitational manifestation when enormous numbers of atoms are bulked together. Why is this so? Prof. Whittaker says : " Assuming that matter is electrical in its nature, it is inferred that matter will be attracted to places of greater dielectric constant."

Keeping, however, to purely mechanical ideas, *surface tension* is suggestive.

If, as stated in section I, a few bubbles are formed some distance apart on the surface of a suitable liquid, it will be seen that they often ' gravitate together,' so to speak. The ' attraction ' is a surface-tension phenomenon.

The surface is discontinuous where it meets the air, but the æther is seemingly continuous. How then is one to import such a remote idea into the domain of the æther mechanism—if it may be so called—which is nearer the electrostatic-field state, shall it be said, than the mechanical?

The answer seems to be in the stars, and in atoms, and mathematically in the quantum theory; for here discontinuity reigns supreme; yet the discontinuity is confined particularly to the atom : in short it reduces to the atom.

The æther is then discontinuous and has a sort of surface tension : But where? and how? and when?

Again a difficulty arises. Big objects are not necessarily heavy; or, even substances reduced to the finest powder with great surface are often very light in weight. This seems fatal to any surface-tension idea. There is a missing piece of knowledge here.

Prof. Whittaker says that a definite connection exists between electricity and gravitation, and that the whole of the electromagnetic theory will have to be re-written. Unfortunately, Maxwell is not here to clear up some phases of his mathematical theory, known to be unduly mysterious.

Again, Prof. Whittaker says :" Gravitation simply represents a continual effort of the universe to straighten itself out." This he remarks is the *general relativity* in a sentence.

Yet this is strange, for matter is always wanting to get together rather than disperse. Even gases cling to planets (Mercury might be excepted but this does not affect the generality of the argument), and gases condense to a slight extent on all manner of surfaces.

In seeking for some universal principle on which to build the whole foundations of the relativities it appears that Hilbert's Minimum Principle of 1925 is evoked. This accounts for the above-quoted statement, for it is curvature that is important in the *general* relativity theory. Gravity acts to make the *total* amount of curvature of space-time a minimum.

It will be seen that however strange or contrary a statement may seem at first, when understood it fits the case admirably. So, going back to the surface-tension idea that was wholly out of keeping with facts, here, too, some way of translating the idea is necessary.

(To be continued.)

I take this opportunity to correct an error in my article in this Journal, March 4, 1927, p. 131 :—4th line down : " Procyon " should read : like one of Procyon.

On p. 341 (this vol.), 2nd column, 3rd line down : " 10 [illegible] " should read : 10[illegible] .

It should be noted that some minor irregularities in the mode of expressing equations were due to their planning so that they could be set up by " macbine composition," and thereby save expense, at the same time a natural order of manipulation was preserved. This entailed one or two omissions to avoid too lengthy an exquation or hand setting, but there should be no mistaking the meaning, especially as double equations were given. The use of parentheses was, however, overdone.

F. H. L.

GENERAL NOTES.

CENTRAL EUROPE AND BRITAIN'S CONTINENTAL TRADE.

As far back as the year 1640 one finds English textiles mentioned in a memorandum on taxation issued by the Leipzig City Council, and it is known that even at that early date a regular trade was done in these materials at the Leipzig Fair. The trade was reciprocal, for England was at that time buying brass and hardware and miscellaneous goods at the Fair. In 1729 (states a report concerning that year) the trade in English goods had fallen off. The trade with England is mentioned again in 1738 and 1743 in reports issued by Leipzig merchants. Then the next we hear of the subject is in a memorandum on the City's trade in 1763. The growing volume of the trade is evident, for, say the Leipzig merchants :—

" There is no doubt the English business has been the best Saxony has experienced,

Leipzig's imports from England amount to 4½ million florins, if not more, the chief items being woollen and camel hair plushes, half silk, silk, woollen and cotton fabrics." Britain's re-export trade is mentioned in connection with West Indian produce such as drugs, dye-wool, indigo, cochineal, sugar, coffee, rice, alum, vitriol and spices.

By 1799 the situation in England had a marked effect on the actual volume of business of the Fair. Business failure here upset credit business even with other countries, for bills on London were the tender of the Russian, Polish and Turkish buyers. When in 1801 England concluded a peace treaty with France, London's exchange rate went up and Leipzig felt the advantage at the Autumn Fair. The imports of English manufactures increased steadily during the first years of the nineteenth century and Leipzig practically became the centre for Britain's trade with Germany and Central and South Europe generally. The French occupation of Leipzig and embargo of British goods in its turn certainly upset business there and with regulations framed against British merchandise, the confiscation of goods and so on, it is not until the end of the chaos in 1815 that a big revival is noted. From then the trade shows almost continuous improvement.

It is interesting to recall, when one remembers that to-day there are well over forty British Exhibitors at the Fair, and some thousand or more British Buyers go to Leipzig regularly, that in 1748 the Fair was visited by only six Englishmen, by sixty in 1790, and by about 160 in 1815. At this year's Autumn Fair, which is of course much smaller than the Spring counterpart, there were 9,000 Exhibitors, of whom 535 were foreigners; 120,000 registered Buyers, of whom 12,000 came from abroad. As a world's market place, Leipzig grows on international accord.

The 1928 Spring Exhibition will be held from March 4 to March 14, 1928.

THE ALKALI INDUSTRY IN CANADA.

The primary raw material of the alkali industry is common salt, and although Canada possesses large deposits of this material her production of the sodium alkalis—caustic soda, soda ash, etc., does not satisfy her requirements, the total imports of these products for the year ending March 31 ,1927, being valued at $1,285,849.

Three forms of sodium sulphate are used in industry, viz., Glauber's salt, salt cake, and nitre cake. In Canada, Glauber's salt occurs in nature both as a solid and as a brine in many alkaline lakes of Western Canada. However, on account of its high water content, it would be necessary to dehydrate the material so as to reduce the cost of transportation. Salt cake is obtained as a by-product in the manufacture of hydrochloric acid from common salt, while nitre cake is obtained as a by-product in the manufacture of nitric acid.

CANADA'S GREAT WHEAT CROP.

Canada's great crop of wheat in 1927, the second largest in the history of the Dominion, is confirmed in the provisional estimate of the yield of cereal crops issued by the Dominion Bureau of Statistics. The report is based on conditions at the end of October, with threshing partly completed.

For Canada as a whole, the total wheat crop is estimated at 444,282,000 bushels, compared with 409,811,000 bushels last year. Canada's record crop was in 1923, when 474,199,000 bushels of wheat was harvested. For the three Prairie Provinces this year's wheat crop is estimated at 418,992,000 bushels compared with 388,440,000 bushels in 1926.

For all Canada the yields of the other principal grain crops are estimated provisionally in bushels, with last year's final estimates in brackets as follows:—Oats, 452,421,000 (383,419,000), barley 98,242,000 (99,634,100), fall rye 12,410,400 (9,882,000), spring rye 3,660,100 (2,231,900), all rye 16,070,500 (12,113,900), peas 2,779,000 (2,635,000), beans 1,090,800 (1,159,500), buckwheat 11,016,000 (9,932,300), mixed grains 34,707,000 (34,559,000), flaxseed 4,735,200 (5,947,700), corn for husking 4,355,000 (7,815,000).

GLAUBER'S SALT TO BE PRODUCED FROM SASKATCHEWAN NATURAL DEPOSITS.

The Whiteshore Salts and Chemical Company intends to establish at Palo, Sask., a drying plant for the dehydration of the natural sodium sulphate salts, of which one of the largest deposits in the world is situated in that district. The establishment of a straw paper industry in Western Canada is expected to prove an additional outlet for the product.

The utilisation of the Glauber's salt or sodium sulphate deposits of Saskatchewan is a new venture and already the Palo Company has shipped out 8,000 tons of crystals

nostly to the nickel industry of Sudbury and the textile industries of Quebec. Large quantities are used in the manufacture of sulphate wood pulp. It is expected that the erection of a dehydration plant at a cost of $100,000 and the marketing of the salts in a dry form will greatly increase demand. Experts estimate the deposits at 20 million tons, with a rebirth of crystallisation amounting to 4 million tons annually.

BOARD OF TRADE ANNOUNCEMENT.

SAFEGUARDING OF KEY INDUSTRIES.

There will be a Hearing on Tuesday, January 17, of the complaint which the Board of Trade have received under Section 1 (5) of the Safeguarding of Industries Act, 1921, that Calcium biphosphate (Baking Powder quality) has been improperly excluded from the list Iii, or articles chargeable with duty under Part I of tnat Act, as amended by Section 10 of the Finance Act, 1926.

The Hearing will take place at 11 a.m., in the Main Conference Room, Board of Trade, Great George Street, London, S.W.1., and the tribunal will consist of Mr. A. A. Hudson, K.C., the Referee, and Professor F. G. Donnan, C.B.E., F.R.S., and Professor J. F. Thorpe, C.B.E, F.R.S., who have been selected by the Lord Chancellor for the purpose of this arbitration from the panel constituted under Section 10(4) of the Act of 1926.

MAGNETIC FIELDS.

At the recent 265th Anniversary Meeting of the Royal Society, Sir Ernest Rutherford, the President, referred to the efforts made in recent years to produce intense magnetic fields and high voltages for scientific purposes. By means of modern electrostatic machines it was not difficult to produce weak direct currents at potentials from 200,000 to 300,000 volts, while a large well-insulated induction coil could give momentary voltages of a similar magnitude. The wide use of X-rays for diagnostic and therapeutic purposes had led to a marked improvement in apparatus for exciting intense X-rays. The reguirement of very penetrating X-rays for deep therapy in our hospitals had led to the construction of comparatively light transformers, which would supply the requisite small currents at voltages between 300,000 and 500,000. One of the simplest ways of producing very high voltages was by the Tesla transformer; with that it was not difficult to produce voltages of the order of a million volts, and he understood as much as five million volts had been obtained in the Carnegie Institute at Washington. The rapid frequency of the oscillations and the comparatively small energy given to the secondary of a Tesla coil had, however, restricted its use for general technical purposes as a source of high voltages, although it was now finding an application for the testing of insulating materials.

The increase of the operating voltage of electrical transmission lines had led to the need of very high voltages to test the insulating properties of those lines and their transformers and the effect of electric surges in them. During the last few years a number of high voltage plants had been installed for testing purposes in various countries, which gave from one to two million volts. Those voltages might be obtained either by a very large well-insulated power transformer or, more generally, by a cascade method employing several transformers. There appeared to be no obvious limit to the voltages obtainable by the cascade arrangement, except that of expense and the size of the building required. He was informed that the General Electric Company, of Schenectary, had a working plant giving a maximum of 2,000,000 volts, and hoped soon to have one to give six million volts.

While no doubt the development of such high voltages served a useful technical purpose, from the purely scientific point of view interest was mainly centred on the application of those high potentials to vacuum tubes in order to obtain a copious supply of high-speed electrons and high-speed atoms. A vigorous attack on that side of the question had been recently undertaken by Dr. Coolidge, who, taking advantage of the great improvements in vacuum technique and the ease of supply of electrons from a glowing filament, had constructed an electron tube which would stand 300,000 volts, the rays passing into the air through a thin plate of chrome-nickel-iron alloy about 0.0005 in. thick. It had not so far been found practicable to apply much more than 300,000 volts to a single tube, on account of the danger of a flash over. For the application of still higher voltages a number of tubes were arranged in series and communicating with one another, the fall of potential in each being about 300,000 volts. So far experiments had been made with three tubes in series and 900,000 volts, which gave a supply of electrons corresponding to one or two milliamperes through

the thin window in the last tube. That gave an intense beam of high-velocity electrons which spread out into a hemisphere extending to a distance of about two metres from the window. Marked luminous effects were produced in the air itself and in phosphorescent bodies placed in the path of the rays.

BELGIAN DIRECTOR FOR IMPERIAL CHEMICAL INDUSTRIES.

The Directors of Imperial Chemical Industries, Limited, announce that M. Ernest John Solvay has been elected a member of the Board. M. Solvay is the son of M. Armand Solvay (Chairman of the well-known Belgian firm of Solvie et Cie) and grandson of M. Ernest Solvay, the inventor of the Ammonia Soda process and the founder of the firm of Solvay et Cie. It was through the co-operation of M. Ernest Solvay and Dr. Ludwig Mond that the Ammonia Soda process was introduced into England, and this led to the formation of Brunner Mond & Company, Limited. Solvay et Cie have been represented on the Board of Brunner Mond & Co., Ltd., for many years, and friendly relations have existed between the two companies since the commencement.

ROYAL INSTITUTION.

New Members.

A General Meeting of the Members of the Royal Institution was held on Monday afternoon, December 5, Sir Arthur Keith, Treasurer and Vice-President, in the chair. The special thanks of the Members were returned to Sir Ernest Moon for his donation of £500 to the Research Fund. Mr. W. H. Barnes, Mr. R. D. Blattner, Miss C. M. Demuth, Mr. E. M. Fraser, Mrs. Freeth, Mr. H. W. Hammond, Mr. A. L. Harrison, Mr. W. P. Jesse, Dr. Lloyd, Mrs. McWilliam, Mr. R. W. Marriott, Mr. A. W. Mond, Mr. H. Mond, Mr. J. G. Nicholson, Mr. R. North, Mrs. Riviero, Mr. F. W. Shurlock, Mr. L .H. Swinbank and Mr. G. I. Taylor, were elected Members.

AMERICAN MINING COMPANY SECURES INTEREST IN NOVA SCOTIA TUNGSTEN MINE.

The Halifax (N.S.) correspondent of the Montreal *Financial Times* reports that the American Smelting and Refining Company has taken up an option on the scheelite and gold area situated at Indian Path, near Lunenburg, Nova Scotia. These areas were taken up in 1926 and active development has been going in for the past twelve months under the direction of the Indian Path Gold Prospecting Syndicate. The development work is stated to have exposed important bodies of low grade ore as well as scheelite ore of good grade. It is stated that the assays show the latter to run as high as 73 per cent. WO_3.

The entry of the America Smelting and Refining Company into the mining industry of Nova Scotia is viewed in mining circles in the Province as a particularly promising development.

ANNUAL EXHIBITION OF SCIENTIFIC APPARATUS.

The Eighteenth Annual Exhibition of Electrical, Optical and other Physical Apparatus will be held in the Imperial College of Science and Technology, South Kensington, London, on January 10, 11 and 12, 1928.

This Exhibition is organised by the Physical Society and the Optical Society, and members of the Society of Glass Technology have been invited to contribute exhibits illustrating the results of recent physical researcb on glass or scientific instruments and improvements in laboratory practice.

Offers should include preliminary particulars as to space required (for which no charge will be made), electrical supply, etc., needed for demonstrations contemplated, and should be addressed at once to the Secretary, Physical and Optical Societies, 1, Lowther Gardens, Exhibition Road, London, S.W.7.

THE CHEMICAL SOCIETY.

The Library of the Chemical Society will be closed for the Christmas Holidays at 1 p.m. on Friday, December 23, and will re-open at 10 a.m. on Thursday, December 29.

KIRKLAND LAKE GOLD AREA, ONTARIO.

By Arthur Buisson.

The gold rush into Larder Lake in 1906 resulted in many claims being staked near Kirkland Lake, but the first discovery was not made until 1911 on what is now the Wright-Hargreaves Mine. This was followed by a find on the Tough-Oakes property, which made a small shipment of high-grade ore in 1913, the first from the

camp. In 1915 production had already exceeded the half million dollar mark and remained fairly uniform until 1920 when it rose to more than a million dollars. It has since increased gradually; to over 3 million dollars in 1924, to over 5 million in 1925, while for 1926 is exceeded 7 million dollars.

Development has been carried to its greatest depth in the Kirkland Lake mine, the lowest level of which is at a depth of 2,300 feet. The Lake Shore, Wright-Hargreaves, and Teck-Hughes, with their deepest levels respectively at 1,800, 1,500 and 1,900 feet, are gradually extending their shafts and workings to greater depths with 2,000 feet as the minimum objective. The gold production is derived from two main veins, No. 1 and No. 2, and values range from a few dollars up to 300 dollars per ton.

The treatment of the ore, which is fairly uniform throughout the camp consists essentially of coarse crushing in stages, followed by fine grinding in ball and tube mills, cyanidation, and precipitation with zinc dust. The presence of tellurides is troublesome and is responsible for a certain loss of gold in the tailings. As a result of experiments carried on by some of the chief operators, however, it is proposed to remedy this defect by the introduction of flotation into the mill circuit. This will remove from the pulp the comparatively small amount of rich tellurides and these can then be treated separately for the recovery of the gold they contain.

The Argonaut at Beaver House Lake has discarded cyanidation; and mill practice here consists of crushing, grinding in ball and tube mills, table amalgamation and oil flotation. Resort has been had to this method owing to the high copper content of the ore, which runs in places as high as five per cent. Production from this mill includes gold bullion and copper concentrates.

A number of operators whose properties have not as yet reached the producing stage are carrying on extensive development campaigns of diamond drilling. The outlook for this area is most hopeful, and the next few years will no doubt witness remarkable expansion and increased production.

JAPAN.

News has just been received that the United Japanese Chambers of Commerce have decided to promote a large exhibit at the forthcoming Leipzig Spring Fair which commences on March 4, 1928. Space booked, 1,800 square feet.

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

The following papers were read at the meeting held on Thursday, December 8:

An X-ray Study of the Heat Motions of the Atoms in a Rock-Salt Crystal. By R. W. James and E. M. Firth. Communicated by W. L. Bragg, F.R.S.

1. The ratio of the intensity of reflexion of X-rays by rock-salt at the temperature of liquid air, to that at room temperature, has been measured for a number of spectra. The results show that the temperature factor is of the form exp. $\{-bf(T)\sin^2\theta/\lambda^2\}$, the exponent being proportional to $\sin^2\theta/\lambda^2$, or to the square of the order of the spectrum, within the errors of experiment.

2. The results of these experiments, combined with those made at higher temperatures, and described in an earlier paper, are compared with the theoretical expressions for the temperature factor deduced by Debye and Waller. The results, up to about 500° abs., agree fairly well with the theory of Waller.

3. The absolute value of the integrated reflexion for the (200) spectrum from a rock-salt crystal had been redetermined, both for molybdenum and rhodium $K\alpha$. An estimate of the "extinction" for this crystal for molybdenum radiation has been made.

4. The method of Fourier analysis has been used to calculate the distribution of electrons between the (111) planes of the crystal at different temperatures, and from the broadening of the peaks in the distribution curves the mean amplitudes of the atomic vibrations have been estimated.

5. This estimate of the amplitudes of the atomic vibrations is checked by means of an approximate calculation, which leads to results of the same order.

On the Temperature Factors of X-ray Reflexion for Sodium and Chlorine in the Rock-Salt Crystal. By I. Waller and R. W. James. Communicated by W. L. Bragg, F.R.S.

On the assumption that zero-point energy, having Planck's value, exists, the separate temperature factors of X-ray reflexion, e^{-M_1} and e^{-M}, for the Cl and Na atoms in a rock-salt crystal are determined, using the experimental results of James and Miss Firth. The factor is found to be greater for Na than or Cl, indicating that the Na atoms are the less firmly bound in the

crystal lattice, and therefore have a greater mean amplitude of vibration than the Cl atoms. From the values of the temperature factors the root-mean-square amplitudes of vibration of Na and Cl are found to be 0.242 A and 0.217 A respectively at 290° abs.

The values of M for the individual atoms cannot be obtained theoretically without a detailed knowledge of the interatomic forces, but a certain mean value can be determined in terms of the elastic constants of the crystal. This value is found to be in good agreement with that obtained directly from the experimental results.

The curves showing the atomic scattering power of Na and Cl as a function of the angle of scattering are drawn corresponding to absence of all heat vibration, and are compared with those given by James and Miss Firth who assumed absence of zero-point energy.

It is found that Waller's theorctical formula for the temperature factor agrees with experiment from 86° abs. to about 500° abs. if allowanee is made for the difference in M for the two atoms.

The Structure of Surface Films. Part X. By N. K. Adam, W. A. Berry and H. A. Turner. Communicated by Sir William Hardy, F.R.S.

Two series with liquid expanded films of area (at no compression) different from 48 sq. A.U. have been found, the phenols of 39 and the α-monoglycerides of 70 sq. A.U. The hypothesis of coiled chains for the liquid expanded films cannot therefore be maintained. The possibilities of tilted molecules are discussed and the evidence found inconclusive in favour of any specific form of a tilted molecule theory, although all forms appear possible.

Since the heads appear to contribute to the cohesion in the expanded films, Langmuir's theory that the chains hold the films together against a disruptive force exerted by the heads appears incorrect. The monoglycerides form condensed films with close-packed heads, not appreciably rearranged by compression, area 26.3 sq. A.U. at no compression. Muller's suggestion that the chains are tilted is not incompatible with the theory of close-packed heads. The condensed film of dodecyl phenol shows hysteresis on compression and decomposition.

THE PHYSICAL SOCIETY.

Proceedings at the Meeting held on Friday ,November 25, 1927, at the Imperial College of Science, South Kensington, London, E. H. Rayner ,M.A., Sc.D., in the Chair :—

The following were elected Fellows of the Society : Geo. E. Harrison, M.Sc.; M. O. Pelton, B.Sc.

The following paper was read :—

On the Measurement of the Electrical Resistance of Porous Materials. By A. E. Knowler, M.Sc., A.Inst.P.

Abstract.

A method is described whereby the resistance of a material is measured independently of that at the surfaces in contact with it. The method is specially suited to the measurement of the resistance of ceramic, refractory, and building materials. Results show that the conductivity of a building stone is nearly proportional to its moisture content.

Discussion.

Mr. J. H. Coste : The author states, "The conductivity appears, therefore, to be almost entirely due to the moisture." Having regard to the very small conductivity of water, the author will doubtless agree that the actual conductivity is due to the ions dissolved by the water taken up. If, as one presumes, distilled water was used, these ions must be derived mainly from the stone itself, and in the case of limestone would be Ca″ and CO_3″ or HCO_3′, unless, of course, other more soluble salts were present.

The author does not state the actual water content of the stone from Corsham Down ,but limestones may contain from about 1 to 12 per cent. of water, according to their physical character. The specific conductivity of an approximately saturated solution of calcium carbonate in distilled water containing 0.0016 per cent. $CaCO_3$ was about 30×10^{-6} mho. Having regard to the conductivities found my Mr. Knowler and the probable percentage of water, one appears bound to assume that other ions than those mentioned contribute to the conductivity.

That the conductivity of stone and such materials is due to the effect of moisture seems a necessary conclusion, as no obvious means of producing detachable electrons except by ionic dissociation seems applicable.

The author's method may have some application in examining the hygroscopic state of stones in buildings.

Dr. B. A. Keen: Many investigations similar to those described in the paper have been made on wet plastic materials, such as soil and clays, and also on soils that have been ignited to destroy their colloidal properties. In the latter material a linear relation obtains between conductivity and moisture content over the greater part of the moisture range; but when the moisture falls to 7 per cent. the curve bends sharply towards the conductivity axis. It is still linear, but cuts the moisture axis at 3.5 per cent. These results are quite reproducible. The interest of these discontinuities lies in the light they thow on the distribution of water in a granular mass. Calculations for an aggregation of spheres show that with cubical packing a continuous film of water over the spheres just ceases to be possible at a moisture content of 8 per cent., owing to the increasing curvature o fthe menisci in the annular wedge-shaped regions surrounding the points of contact. Similar calculations for close packing show a corresponding value of 3.5 per cent. The correspondence of these values with experimental determinations indicates the rupture of the film of water over the grains at 8 per cent., which allows a redistribution of the remaining water under surface tension. This process goes on until the last films break, and the remaining water is left in a series of isolated wedges throughout the mass. The author might try materials of a more granular structure—*e.g.*, oolitic limestone and sandstones—and see whether the theoretical results, confirmed for soil, also apply in these cases.

GEOLOGICAL SOCIETY.

The Lower Carboniferous Rocks of the Menaian Region of Carnarvonshire: Their Petrology, Succession, and Physiography. By Dr. Edward Greenly, V.P.G.S., with Palæontological Notes by Dr. Stanley Smith, M.A., F.G.S.

The term Arvon is a convenient designation for the Menaian region of Carnarvonshire.

The Lower Carboniferous rocks of Arvon, like those of Anglesey, consist in the main of a limestone series with many beds of sandstone and shale. At the top of the series there is, as in Anglesea, a series of bedded cherts; but the Millstone Grit and Coal Measures are absent, being cut out by the unconformity at the base of the Red Measures. There is a Basement Conglomerate of the normal type, with rolled pebbles of the Mona Complex.

In Arvon, however, this is underlain by a singular formation, composed of yellow and red loams and breccias, which are studded with pisolites of göthite and kaolinite. The blocks in the breccias are angular, and the loams are unstratified. The loams are of alien, the blocks of local, derivation, the blocks not being derived from the same horizon of the Mona Complex as those in the overlying conglomerate. The extent of this formation seems to have been less than 6 square miles.

The limestones are rich in corals and branchiopoda, and are all in the Zone of *Dibunophyllum*, every division of which is present. The sandstones and shales of the Basement Series have yielded plants.

The structure is that of an asymmetrical synclinal infold, truncated by a large boundary-fault.

The Series rests with complete unconformity upon the Mona Complex and the Ordovician rocks; and there is rapid overlap in a west-north-westerly direction. From the direction of the overlap, and from the contents of the conglomerates, it is inferred that the region which is now Snowdonia was completely submerged in Lower Carboniferous times. The pre-Carboniferous land, which was a branch of the ancient uplands of Anglesey, was lofty. On its south-eastern slope, it steepened into a crag, against which the breccias accumulated. This ancient upland was largely composed of Ordovician shales, with a large inlier of rocks of the Mona Complex. Owing, however, to its height, combined with the effects of the tectonics of the Complex, the outcrops on the inlier were quite different from those of the Menaian Platform of the present day. During the subsidence, different horizons were presented to waste, thus accounting for the contrast between the breccias and the conglomerates.

At first, the climate seems to have been arid, with a large diurnal range of temperature; but, as the subsidence advanced, moist and genial conditions began to set in, persisting throughout the remainder of the period represented by the limestone series.

JUGO-SLAVIA AND INTERNATIONAL EXHIBITIONS.

The Jugo-Slavian Finance Minister has just authorised the Minister of Commerce to spend a considerable amount of money in connection with an official exhibit at the next Leipzig Spring Fair and which will be one of the main attractions.

AN ANALYSIS OF THE ARC AND SPARK SPECTRA OF SCANDIUM (Sc I AND Sc II.)

By Henry Norris Russell and William F. Meggers.

(Scientific Paper, U.S.A. Bureau of Standards.)

Abstract.

In the present analysis spectral term combinations have been assigned to 353 lines of Sc I and 142 of Ss II. Nearly all of the observed lines in both spectra are thus classifietd.

Details of the spark spectrum (Sc II) are presented first, because they are simpler. The terms with lowest energy content are ^{3}D, ^{1}D, arising from the electron configuration 3*d*.4*s*. Next come ^{3}F′, ^{3}P′, ^{1}S, ^{1}D, ^{1}G from 3*d*.3*d*. All these terms combine with ^{3}P, ^{3}D′, ^{3}F; ^{1}P, ^{1}D′, ^{1}F from 3*d*.4*p*; and these again with ^{3}S, ^{3}P′, ^{3}D, ^{3}F′, ^{3}G; ^{1}S, ^{1}P′, ^{1}D, ^{1}F′, ^{1}G from 3*d*.4*d*, and ^{3}D, ^{1}D from 3*d*.5*s*. The last are in series with the lowest terms, and the ionisation potential of the Sc^+ atom is indicated by these series to be 12.8 volts. A ^{3}P term arising from 4*s*.4*p* and a ^{3}P′ term from 4*p*.4*p* are also present.

The arc spectrum (Sc I) is much more complex. The lowest-energy term, representing the normal state of the Sc atom, is ^{2}D, which originated with the three-electron configuration 3*d*.4*s*.4*s*. Next follow the metastable states ^{4}F′, ^{2}F′, ^{2}D, ^{2}G, ^{4}P′ arising from 3*d*.3*d*.4*s*. The configurations 3*d*.4*s*.4*p* and 3*d*.3*d*.4*p* give numerous "middle" terms combining with the low ones and also with higher terms arising from 3*d*.4*s*.5*s*, 3*d*.3*d*.5*s*, 3*d*.3*d*.3*d*, 3*d*.4*s*.4*d*. and 3*d*.4*p*4*p*. The two terms first mentioned, ^{2}D and ^{4}F′, begin two series from which an ionisation potential of 6.7 volts is obtained for the neutral Sc atom.

The theoretical interpretation of the observed terms is outlined, and all details of the structure of both arc and spark spectra are found to be in complete agreement with Hund's theory, which derives one or more specific spectral terms from each possible configuration of the electrons not in completed groups.

Results of this analysis are presented in the form of term tables, multiplet tables, tables of classified lines, and energy diagrams for each of the spectra.

Scandium is the lightest element which exhibits a spectrum of the type characteristic of the heavier metals, in which the lines are very numerous, multiplets are abundant and series inconspicuous. The first step toward analysis of its spectrum was made by popow, who identified a PD group in the ultra-violet, belonging to a triplet system. Later, Catalán found a number of additional multiplets of the triplet system in the spark spectrum, and detected doublets and quartets in the arc spectrum. His analysis was extended, and some of his conclusions corrected by Meggers, who showed that the state of lowest energy in the neutral atom corresponds to a ^{2}D term, and the next lowest state to a ^{4}F′ though the relative levels of these terms were not exactly assignable, since no intercombinations between the systems were found.

In the singly ionised atom, the lowest term was found to be a ^{3}D, with a ^{3}F′ and ^{3}P′ somewhat higher. Transitions ending in these atomic states account for most, though not all, of the more prominent arc and spark lines. Many important lines, and numerous fainter ones, were, however, left unclassified.

More recently Hund has accounted for these terms, in a very satisfactory manner, by means of his theory of atomic and spectral structure; and Gibbs and White and Stanley Smith have identified the most important terms in the spectrum of the doubly ionised atom (Sc III) and shown that the ^{2}D term is here the lowest, as surmised years before by Bohr.

The present analysis, begun some time ago by one of us (W.F.M.) and delayed by pressure of other duties, has been completed by the other. The number of liues whose relations have been identified is 142 for Sc II and 353 for Sc I. Were it not for the scarcity of scandium, which makes it impracticable to use long exposures in the search for faint lines, these numbers could probably be considerably increased. As it is, only a few scattered lines of small intensity remain unclassified, and the analysis may be regarded as practically complete, under the existing limitations. It has been possible to interpret almost all the terms which have been found by means of Hund's theory, to identify the corresponding atomic configurations with security, and thus to find th ebeginnings of series, which lead to the determination of the ionisation potentials for the removal of both the first and the second valency electrons.

"P.C.R." PISTON RING AND THE PACKING RING TESTER.

By Masatosi Okochi and Keikichi Ebihara.

(Inst. of Physical and Chemical Research, Tokyo.)

Introduction.

Nowadays the compression pressure of the internal combustion engine has become high, and it may still be higher if improvements in the technical details should be achieved. As the result of this increase of pressure, there arises much difficulty in packing the piston of the engine and good piston rings are indispensable in demand.

The usual method of getting gas tightness by piston ring is to increase the intensity of spring action of the ring by applying the mechanical operation of hammering the inside of the ring, or simply using a material of higher modulus of elasticity. As to the merit of the hammered ring, it is believed that not only the spring action of the ring is intensified but also a nearly uniform pressure is distributed on the cylinder will. Nevertheless the actual observation measured by the special instrument invented by us shows quite an opposite result, as the authors pointed out of late. There is no satisfactory interpretation as to why the stron gspring action of the ring is preferable for the packing action. A perfect contact of the two surfaces is sufficient in practice to prevent the leakage of gases under any pressure. For example, a hollow cylinder having its inner surface well ground to fit a solid piston of good finish should not permit any passage of the gas which is compressed by the piston, provided the cylinder wall is not expanded by the internal pressure. It is, therefore, simply an absurd idea to have a higher pressure between the two contact surfaces in order to get a better obturation performed. In fact the pressure existing between the outer surface of the piston ring and the cylinder wall plays no principal role in impeding the leakage of gases, but a perfect contact of the two surfaces is a necessary condition to be attained by all means for the obturation purpose, and the said pressure is preferred to be low enough to bring the outer surface of the ring just in contact with the cylinder wall, even in case the cylinder is expanded under the gas pressure or the effect of high temperature.

Many engine makers, on the contrary, are using a ring which has a very strong spring action, exerting enormous pressure on the several parts of the cylinder wall, so that the ring is strained by this spring action and obliged to make a slight contact with the other part of the wall, where no touch may be found when the spring action of the ring is weak. This is the only merit of the ring with a strong spring action and its bad workmanship is concealed by this spring action. It is now clear that the most important thing is the uniform distribution of pressure of packing ring on the cylinder wall with slight but complete contact to minimise the frictional resistance of the piston and the wear of the cylinder wall in a long run of the engine. When a ring of strong spring action with an irregular pressure distribution is used, not only the mechanical efficiency of the engine diminished by undue frictional resistance but also the eccentric wear of the cylinder becomes conspicuous enough to need the reboring or grinding of the cylinder.

The above considerations refer to internal combustion engines, but the same reasoning holds good for air or gas compressors, steam engines, and any other engines using piston packing rings. In the case of low pressure engines, however, the defects of the ordinary rings are not so noticeable, and consequently the question of obturation draws less attention.

Professor A. Inokuty theoretically found an ingenious device of making a ring having uniform pressure distribution on the cylinder wall, for which the following condition must be obtained.

$$l = \frac{9\pi p D^4}{4Et^3} \quad \ldots\ldots\ldots\ldots\ldots (1)$$

where l is the gap length, D the internal diameter of the cylinder, E the modulus of elasticity of the ring, t the radial thickness of the ring, p the intensity of pressure which is constant through the circumference of the ring.

Also K. Aichi calculated an eccentric ring, as Unwin proposed, having uniform distribution of pressnre, but he gave no suggestion for manufacturing the proposed rings. Recently R. Bennet has calculated theoretically the form of the ring in its free state, which exerts a uniform pressure on the cylinder will. The rings are turned out from a cast iron cylinder under the guide of the template which has a similar form to the ring of uniform pressure in its free state. These rings were used or the superheated steam locomotives of Swedish railways in which the rings of the original hammered type were also used. After running 80,000

kilometers both kinds of rings and the cylinders were carefully examined and the Bennet rings showed exceedingly good results. His method of manufacturing the rings is, however, too complicated and does not, it seems to us, admit of mass production.

NOTICES OF BOOKS.

The Phase Rule and Its Applications. By ALEXANDER FINDLAY, M.A., D.Sc., F.I.C (Text-Books of Physical Chemistry Series, Edited by Sir William Ramsay and F. G. Donnan). Pp. XVI + 326, with 158 figures in the text. Price 10s. 6d. net. London: Longmans, Green & Co., Ltd., 39, Pater noster Row, E.C.4.

This important work was first published in 1904, and the present edition has apparently been largely re-written in order to bring it up-to-date. In addition, new sections and illustrations have been added. elucidating several points in connection with salts in solution. The result has been the making of a valuable scientific book, which will be found helpful to student or the more mature scientist, who wishes to have at hand an authoritative work on the phase-rule and its many applications. There is given a useful appendix—Determination of the Transition Point—and full name and subject indexes. Included in the text are five beautiful plates, the last shewing isothermal curves for the system $FeCl_3$ - HCl-H_2O. The illustrations number 165 Altogether it is a valuable and well-produced scientific work at a remarkably low price.

Properties of Refractories in Zinc Metallurgy. By E. S. WHEELER, Assistant Research Metallurgist, A. H. KUECHLER, Junior Ceramic Engineer, Missouri School of Mines and Metallurgy, AND H. M. LAWRENCE, Metallurgist, U.S. Bureau of Mines. Published in co-operation with U.S. Bureau of Mines.

The frequent renewals of retorts and condensers and the occasional repairing and rebuilding that a furnace requires in the metallurgy of zinc warrant careful consideration of the raw materials, clay and grog, that are used for the manufacture of the refractory shapes. The investigation covers raw materials and body mixtures now in use, the comparative value of various grog materials, the comparative value of various clays, and the effect of reclaimed retort materials and zinc oxide upon the physical properties of retort mixtures. There are detailed discussions of the results obtained by the authors under each subject.

An Introduction of Physical Chemistry. By SIR JAMES WALKER, LL.D., F.R.S., Professor of Chemistry in the University of Edinburgh. Pp. XII + 446. Price 16s. net. London: Macmillan & Co., Ltd., St. Martin's Street, W.C.2.

The author devotes a number of pages of this useful work to Chapter I, which is of a general character, on standards of measurement, in which the importance of the decimal system is justly accentuated. Atomic theory and atomic weights occupy Chapter II. There are 36 Chapters in the whole work, of which the present is the tenth edition, an evidence of its popularity. In the present edition the learned author has aimed at incorporating certain new material so as to keep the work abreast of the progress of physical chemistry, which has been rendered practicable by the curtailment or exclusion of portions deemed obsolete. It is by thus keeping up-to-date in each new edition that the author has secured for his work an established popularity.

Distillation des Combustibles à Basse Température. Par R. COURAU, Administrateur-Directeur Général des Mines de La Houve, ET HENRI BESSON, Ingénieur-Conseil 1 Vol. in-8° de 372 pages, avec 75 figures dans le texte. 40 francs. Paris: Gaston Doin et Cie., 8, Place de L'Odéon.

This is a well-written monograph in French, and there was really no need for the authors to give explanations for adding another to the numerous books on the subject dealt with. There is given a complete index (Table Alphabétique), and a useful bibliographie.

FORTHCOMING EVENTS.

ROYAL INSTITUTION OF GREAT BRITAIN.

21, Albemarle Street, London, W.1.

Thursday, December 29, at 3 p.m.—Juvenile Christmas Lecture: "Engines." By Dr. Edward N. Da C. Andrade, D.Sc. Ph.D., M.R.I. (Prof. of Physics, Military College, Woolwich). (1) "The Rules which all Engines Must Obey." Illustrated with models and experiments.

Saturday, December 29, at 3 p.m.—Second Lecture: "Learning About Steam."

ROYAL INSTITUTION.

The Juvenile Christmas Lectures at the Royal Institution will be delivered by Professor E. N. da C. Andrade on " Engines," commencing on Thursday, December 29. The general courses of Lectures before Easter will begin on Tuesday, January 17, at 5.15, when Mr. P. R. Coursey delivers the first of two lectures on " The Development of Dielectrics for Electrical Condensers." On succeeding Tuesday afternoons there wil lbe three lectures by Dr. A. P. Newton on (1) " The Mercantile Empire, 1606-1783; (2) " The Settlement of the Dominions, 1783-1870; (3) " The Dependent Empire and the British Commonwealth of Nations "; and six lectures by Professor Julian Huxley on " The Behaviour of Animals." On Thursday afternoons at the same hour there will be three lectures by Sir William Bragg on " Faraday's Notebooks "; two by Dr. F. Ll. Griffiths on " Nubia in Antiquity and in the Middle Ages "; two by Dr. J. J. Fox on " Optics and Chemistry "; and two by Group Captain M. Flack on " The Physiological Aspects of Flying." On Saturday afternoons at three o-clock there will be two lectures by Dr. R. W. Chambers on " Some Tndor Biographers "; two by Mr. Campbell Dodgson on " The Life and Work of Albrecht Durer "; and four by Sir Ernest Rutherford on " The Transformation of Matter." The Friday Evening Meetings will commence on January 20, when the discourse will be delivered by Sir William Bragg on " Photo-electricity." Succeeding discourses will probably be given by Miss D. A. E. Garrod, Professor E. C. C. Baly, Professor E. Melvill Jones, Rev. E. M. Walker, Sir Farquhar Buzzard, Professor E. A. Milne, Sir Ernest Rutherford and other gentlemen.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

31,254.—Beckett, E. G.—Manufacture of amino - halogen - anthraquinones. November 21st.

31,290.—Ges. fur Linde's Eismaschinen Akt.-Ges.—Process of extracting ammonia from gases. November 21st.

31,342.—Klapproth, W. Process for purification of lactic acid. November 22nd.

31,393.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of phenlythioglycolic acids, etc. Nov. 22nd.

31,431.—Imperial Chemical Industries, Ltd.—Treating greasy fibrous materials. November 23rd.

Specifications Published.

280,613.—Newbery, G., and May & Baker, Ltd.—Manufacture of organic compounds of arsenic.

263,779.—Moller, Dr. W., and Kreith, Dr. W.—Preparation of solutions of hydro-fluosilicic acid.

280,763.—Urbain, E.—Process for simultaneously producing a gas of the nature of water gas, phosphoric acid, and an aluminium silicate slag having the same composition as a cement.

269,546.—I. G. Farbenindustrie Akt.-Ges. —Recovery of sulphur from solutions of ammonium polysulphides.

269,—556.—Rubber Service Laboratories Co.—Manufacture of acetaldehyde and of acetaldehyde-amine condensation products.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

278,703.—Purifying glycerine.—Vereinigte Chemische Werke Akt.-Ges., 16, Salzufer, Charlottenburg, Berlin.

Glycerine produced by fermentation is freed from smell by treatment with oxidising agents, e.g., hypochlorites, hydrogen peroxide, or permanganates. In examples —(1) 100 kilograms of 80 per cent. crude glycerine are mixed with a solution of 500 grams of sodium hypochlorite, allowed to stand for 6 hours, and distilled; (2) 1.5 kilograms of chloride of lime are stirred into 1 cubic metre of the warm 10 per cent. solution of glycerine obtained when the sulphite has been precipitated with calcium chloride and lime from the fermented mash. After 8 hours the lime is precipitated by soda, and the solution is neutralised and distilled.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His *Majesty's Stationery Office.*

TELLUS.

482,049.—*Ammonia and ammonia products in Class 1, for use in manufactures.*—Synthetic Ammonia and Nitrates, Limited, Chemical Works, Billingham, Stockton-on-Tees, Durham. November 23rd.

CONFIGS.

485,099.—*Chemical substances prepared for use in medicine and pharmacy.*—Batger and Company, Limited, 60 to 102, Brook Street, Ratcliff, London ,E.1. November 30th.

SANASANA BRAND.

483,751.—Chemical substances prepared for use in medicine and pharmacy.—H. R. Napp, Limited, 3 and 4, Clement's Inn, Kingsway, London, W.C.2. November 30th.

DIJODYL.

485,355.—All goods in class 3 which includes chemical substances prepared for use in medicine and pharmacy.—J. D. Riedel Aktiengesellschaft, 1 to 32, Riedelstrasse, Berlin-Britz, Prussia, Germany. November 30th.

CREOLAIT.

481,161.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—Pease and Partners, Limited, 92, Northgate, Darlington, Durham. November 30th.

JUST PUBLISHED.

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THE POETRY OF SCIENCE.*

. . . . .

To searchers all in many lands,
I dedicate these wandering lines
So full of chequer'd, cross'd designs :
Inspir'd with hope my song may find
The fellowship of science kind,
The living for them all, I pray
Accept what at their feet I lay.

A writer in a weekly journal celebrated for its literary articles recently called attention to the present lack of interest in poetry. He emphasised that 99 per cent. of the reading public ignored verse altogether and the *remaining 1 per cent. were only mildly interested* in poetry as a means of conveying ideas. Verse has seldom been used by scientists to give expression to their ideas. A few outstanding examples are not regarded as important contributions to knowledge although Lucretius set a noble example and high standard in his *De Rerum Natura.*

Now " Opifex " has crystallised his faith in the present volume of enchanting poems which are teeming with happy phrases and well-stated ideas. He begins with a sketch of The Atom.

Now, once there was an atom,
Which was very hard and round
According to the datum
Of Democritus, who found
No extra useful purpose
That this atom could fulfil;
He thought he would imburse us
So he left it in his will.

. . . . . .

John Dalton took and weighed it,
Sought it out from all its kind,
And very soon he made it
Do some work for all mankind.

. . . . . .

Clerk Maxwell calculated
Molecules, of gaseous race,
May easily be rated
In their number, size and pace.

. . . . . .

Then J. J. Thomson took it
And, though such a tiny snip,
Eventually shook it,
From its corner knock'd a chip;
This fragment is a wonder,
An " Electron " is its name,
'Twas like a clap of thunder
Over all who heard its fame.

. . . . . .

Discover'd in the centre,
That some little " Protons " lay
And all electrons enter
Into spherical array;

The greater part of the volume is taken up with Intelligence, beginning with (α), its Source, and ending with (Ω) God.

For some the name of God would spurn,
Imagining they can discern
Some flaws in His great plan;
"No brilliant wisdom would permit
Offences great He doth commit
In ways He deals with man."
Is man's importance paramount,
Is he the only source and fount
Of wisdom so profound,
That, since his woes can find no cure,
His egotism makes him sure
No place for God is found?

The author dwells upon mankind's achievements, its ignorance, the Heavens, Life, Truth, Mathematics, Ethics, *Alma Mater*, and many other topics in a manner which commands sustained attention, for he has the spirit of a true seeker after knowledge for its own sake and is scornful of those who would make science the handmaiden of commercialism.

The poem, *Sine Nomine*, leaves the reader to infer that "Opifex" is a chemist.

The undergrad with artful winks,
Still dubs him as the man of "Stinks"
By way of tone;
But otherwise he has no name
His country's law permits him claim
As all his own.
His country, in war-time grim,
Full trustingly relied on him

. . . . . .

Receiving nothing more, as thanks,
He found himself, like damag'd tanks,
Demobiliz'd.

. . . . . .

But what a cost would be incurr'd
So he is put to many shifts,
Confus'd with men of "drugs and gifts"
And Glauber's salt.
The merest trifle he desires,
To *nomen* "Chemist" he aspires,
No more a loan;
A name that all men understand,
An honour'd one in every land
Except his own.

The *Weihnachts Kneipe* will recall happy memories to those who spent student days abroad. "Opifex's" lines aptly portray the spirit of these affairs. The following epigram indicates that he has had household troubles.

The good God sent the food.....
The Devil sent the cooks,
Troubles with editors also came his way.

Altogether, "Opifex's" poems constitute a neat little volume refreshing for the scientist and enlightening to the general reader.

J. G. F. Druce.

Poems, by Opifex. Pp. 106. London: *The Chemical News*. 1927. Price, 5s.

ANTHRAX: ITS NATURE AND CONTROL.

By Dr. P. R. Viljoen
Deputy Director of Veterinary Services, Union of South Africa.

While cases of anthrax occur from time to time in Great Britain (notably among those who handle imported hides, wool, etc., but it is sometimes caused by infected shaving brushes), it, fortunately, never attains the serious proportions that it does in South Africa. As will be seen by the attached article by Dr. P. R. Viljoen, the Union Government, to its credit, has taken drastic steps to check and if possible stamp out the disease. The nature of these measures will be understood from a perusal of the able article by Dr. Viljoen, which we have pleasure in publishing.—Ed., Chem. News.

Introduction.

There cannot be the slightest doubt that anthrax has become a serious menace to the stock-farmer in South Africa, and much attention is being given to measures for its control by the Veterinary Authorities of the Union. The Union Government fully realises the seriousness of the anthrax problem, and in their encouragement of methods for control has authorised the free issue of anthrax vaccine to all stock-owners of the Union. This is undoubtedly a big concession on the part of the Government as at the present rate at which the anthrax vaccine is issued, it will mean a loss of revenue amounting to at least £80,000 per annum. That this is a wise step, and that the money is well spent, no one can deny, since the control and eradication of anthrax have become a national, indeed an international problem.

The disease is communicable to man, and there is a great deal of danger connnected with the handling of hides, skin, and wool derived from infected animals, and the International Labour Conference appointed an advisory committee on anthrax to consider the question of safeguarding the workers. Therefore, from the point of view of international trade, it is in the interests of Union stockbreeders to get anthrax under proper control.

PREVALENCE.

Anthrax has been known in South Africa for many years, but it is only during the last few years that it has assumed serious proportions. There can be no doubt that the disease has been spreading steadily, so much so that at the present time it occurs in most parts of the Union.

CAUSE OF THE DISEASE.

Anthrax is an infectious disease caused by a small bacterium or micro-organism gaining entrance to the body. The organism is endowed with certain characteristic properties, some of which play an important part in the spread of the disease. These are :—

(1) Rapid multiplication :- Given moisture, suitable food and temperature requirements, and access to air or oxygen, the organism multiplies very rapidly; so much *so that one may become several million in* about 6 hours' time. This multiplication takes place under laboratory conditions, or in the animal when its resistance has been overcome.

(2) When suitable conditions for its multiplication are no longer available, the organism can protect itself by the formation of a so-called " spore," *provided it has free access to oxygen.*

In the living animal the organism obtains *deal conditions for its growth and multiplication*, but as soon as the animal is dead, the conditions become unfavourable; the main reason for this is that plenty of oxygen is available in the blood and tissues of the living animal, but this oxygen is exhausted soon after death. In order to multiply or form spores, the anthrax organism must have free oxygen, so that after the death of the animal the organisms can neither multiply themselves, not form spores. The inevitable result will be death before many hours. If, however, the carcass is cut into, *millions of organisms are exposed to the air* or oxygen, and they very quickly form spores. These spores represent the resting stage of the organisms, and are endowed with extremely tenacious properties; they may live outside the animal body, in soil, grass, water, etc., for many years, and this makes the anthrax problem such a difficult one. The danger of cutting into an anthrax carcass is thus apparent, also the reason for the Government regulation forbidding the *skinning of such a carcass.*

ANIMALS AFFECTED AND MODE OF INFECTION.

Man and all his domestic animals (excepting the common fowl) contract the disease naturally. In South Africa cattle, sheep, and goats are the worst sufferers, then come equines, and after that ostriches, pigs, dogs, and cats; the disease is very rare in the last two-mentioned species.

Cattle, sheep, and goats usually contract the disease by eating infected grass or drinking infected water; while pigs and dogs almost invariably get anthrax from eating the meat of animals that have died of the disease.

Equines contract the disease in the same way as the ruminants, but in addition they are often infected through the skin by infected horse-flies.

Human beings contract the disease in different ways : - (*a*) Through wounds in the skin, for example, when working with an anthrax carcass; (*b*) by inhaling dust laden with anthrax organisms. This commonly happens in wool factories, hence the name " Wool-sorter's disease."

SPREAD OF INFECTION.

Anthrax is not a contagious disease in the strict sense of the word, *i.e.*, the infection is not spread in a direct manner from living, sick animals to healthy ones. An animal suffering from anthrax presents a source of infection only in the following *indirect ways* :

(*a*) During the last stages of the disease, when the intestines are particularly involved and blood is passed out with the droppings, the infection may be spread to foodstuffs or water where other animals can again pick it up.

(*b*) In the case of equines showing large anthrax swellings, the horse-flies settling on these, may become infected before the death of the animal, and later convey the infection by settling on healthy animals.

The main source of infection is the carcass of an animal that has died from anthrax. If such a carcass is left unopened and undisturbed, the risk of spreading infection is not so great, because, as previously pointed out, the anthrax organisms can neither multiply nor form spores in the absence of air or oxygen. In many cases blood escapes from the natural openings after the death of the animal, and such blood is dangerous, since the organisms contained in it will form spores. When the carcass is skinned or cut into, an enormous amount of blood is spilt, and in this way millions of anthrax organisms will be given the opportunity of changing over into the spore forms. From the infected spot where

the carcass was opened the anthrax spores can be spread in many ways :—

(*a*) By the removal of the skin, flesh, etc., to other parts of the farm or, in the case of the skin, to other parts of the country. In this country, unfortunately, we have to deal with natives who will eat the meat of dead cattle, sheep, and goats, no matter what the cause of death. Very often these natives escape infection, but through the skinning of the animal and the removal of the meat, they are instrumental in spreading infection far and wide.

Many farmers again are anxious to sell the hides and skins of animals that have died on their farms, and in this way—in most cases in ignorance of the risks involved—they are themselves instrumental in spreading the disease on their farms.

(*b*) Dogs, vultures, etc., may carry portions of an infected carcass long distances.

(*c*) Infected soil is very often washed away by torrential rains, and in this way it is common for vleis, dams, etc., to become infected.

(*d*) During dry periods, anthrax organisms contained in the soil may be carried long distances in the dust.

(*e*) Infected animals while still in the incubative stage, may be moved to clean areas and then develop symptoms and die from anthrax. In this way the disease is commonly spread from infected to clean farms.

(*f*) The trade in bones intended for the manufacture of bonemeal, which has developed enormously during the last few years, involves some considerable danger of spreading anthrax. It is well known that in their anxiety to obtain bones for sale to traders, natives scour the country for all kinds of bones and even dig up old graves. There can be very little doubt that quite an appreciable percentage of such bones must contain anthrax spores, and that their handling creates another source of infection.

Symptoms.

These vary in the different domestic animals, and since they are well known to most farmers, are referred to very briefly.

In cattle, sheep, and goats, anthrax usually occurs in the peracute form, the affected animals dying very suddenly. The usual history is that the animal was found dead in the kraal or the veld, although nothing abnormal was noticed to be present when it was seen a few hours previously. Animals may remain sick for several hours or even days, when the symptoms are high fever, dullness, followed by staggering, difficult breathing, and finally death. Now and again swellings of lymphatic glands, especially those in front of the shoulder joint, are noticed.

In equines, the disease may run the same rapid course as in cattle, but usually it assumes a more subacute form, the affected animals living for several days. This happens commonly in those parts of the country where the disease is contracted through the agency of the horse-fly.

Pigs almost invariably become infected by eating meat, and the most common sign of anthrax in this animal is a swelling in the throat region. Sick pigs show fever, lie about listlessly and some interference in their breathing is soon shown, which becomes more and more difficult as the case progresses. Finally they die with signs of suffocation.

Post Mortem Appearances.

Under the "Stock Diseases Act," the opening of a carcass of an animal that has died of suspected anthrax is strictly forbidden, and for this reason it is not intended to discuss here the port-mortem changes in any detail. When an animal has died suddenly, one must always treat the case as one of suspected anthrax, unless, of course, there is good reason to believe that death is due to something else, like acute poisoning, snakebite, etc.

Diagnosis.

Anthrax is not always easy to diagnose by the history of the case, the appearance of the carcass, etc., but, as already mentioned, the careful farmer will consider every sudden death on his farm, for which there is no apparent reason, as suspicious of anthrax and take the necessary precautions.

The only certain way of diagnosing the disease is by the *microscopic examination of blood smears taken soon after the death of the animal.* Every farmer should, therefore, make it a regular practice to forward to the nearest laboratory *blood smears from every animal that dies* on his farm under suspicious circumstances.

The anthrax organisms do not usually appear in large numbers in the peripheral blood until just before death, and for this reason it is advised to take the smears from the dead animal. Furthermore, it is re-

commended that blood smears be taken as early as possible after death, because if there is too much delay (two or more days) the anthrax organisms will be difficult to recognise owing to their disintegration and to the presence of innumerable putrefactive bacteria.

The smears should be made by cutting into the ear or tail, because in this way very little blood need be spilt, and in these parts decomposition does not take place so rapidly. This Division issues, free of charge on application, pamphlets of instructions for preparing blood smears, and a supply of glass slides.

Sudden deaths also occur in cases of snakebite, acute vegetable poisoning, black-quarter, heat and lightning stroke, choking, etc., and very often it is an extremely difficult matter (excepting by the microscopic examination of blood smears to distinguish between these conditions.

In horses and pigs the diagnosis of anthrax is very often quite a simple matter; in the former because of the characteristic swellings previously referred to, and in the latter because several cases usually occur close together and swelling of the throat region followed by suffocation usually develops.

CONTROL.

This is most important and the main object of this article is to explain very clearly to the farmer the real nature of the disease, so that he may fully appreciate the reasons for the Government regulations which he is expected to carry out.

In *the control of anthrax, the two most important steps to be taken* are the following :—

(1) To destroy all known infection on the farm and to prevent further infection or spread of the disease. This can be accomplished to a large extent by the *proper disposal of all carcasses of animals that have died or are suspected to have died of anthrax.*

(2) To keep the susceptible animals away from the infected parts of the farm or to render them insusceptible to the disease by a proper and reliable method of vaccination.

SOME REMARKS ON THE COLLOID THEORY OF CEMENTS.

By TUTOMU MAEDA.

(Abstracted from *The Journal of Physical Chemistry*, 1927, xxxi., No. 6.)

There are two rival theories, the crystal and the colloid theories, for the setting and hardening of cements. My studies on the setting and hardening of magnesium oxychloride cement lead me to the conclusion that these two theories are complementary and not antagonistic. The so-called colloid theory must be modified, however, because it uses a colloid explanaton for a phenomenon which plays a minor part in the setting and hardening of cements and omits the explanation of more important phenomena from the colloid standpoint.

My studies, so far, have covered the following five topics, and I will discuss the phenomena in view of what I have found.

1. The composition of magnesium oxychloride cement.

2. Viscosity changes during the reaction between magnesium oxide and aqueous magnesium chloride solution, and a new consideration of the setting of cements.

3. A study of magnesium oxychloride cement with X-rays.

4. The aqueous vapour pressure of magnesium oxychloride cement, and the state of water in the cement.

5. The hardening of magnesium oxychloride cement, and the functions of free water, water of crystallisation, and adsorbed water.

With the exception of Michaelis, the supporters of the colloid theory consider that the colloid phenomenon consists in the adsorption of fluid on the surfaces of the solids in the cement mixture. Thus, Cavazzi assumes the direct formation of the so-called gelatinous calcium sulphate, but such adsorption phenomena are not limited merely to cement mixtures. They may also occur as the first step in the reaction when any salt is brought in contact with a liquid or a solution. According to my understanding Cavazzi's gelatinous calcium sulphate can be considered as $CaSO_4.0.5H_2O$ + xH_2O, which decomposes as the second step into $CaSO_4.2H_2O$ and $(x-1.5)\ H_2O$. In this form the colloid theory does not differ much from the crystal theory, for the latter also attributes the settng of cements to the formation of small, interlocking crystals. I wish to ask, however, the function of the water set free $(x-1.5)\ H_2O$ per mol $CaSO_4$.

$2H_2O$. The most important weapon for the supporters of the so-called colloid theory is the function of the added chemicals which modify the rate of setting. Which of the two reactions—the formation of the gelatinous sulphate or the formation of the crystalline sulphate—is influenced by these chemicals? Various chemicals, of course, play an important part in the coagulation of a colloidal system. To which of the two reactions does coagulation correspond?

The colloid theory does not explain the cause of hardness from a colloid standpoint but adopts the latter part of the crystal theory. Are there any crystals in a set *gelatin?*

I am willing to accept the hypothesis of the first adsorption of a fluid on the surfaces of the solids in a cement mixture, but I do not consider it important for the phenomenon of setting because it is evident that an immediate solution of the solids takes place to some extent, since the fluid has some solvent action on the solids. Some $CaSO_4 . 0.5H_2O$ will therefore dissolve in water and some magnesium oxide will dissolve in magnesium chloride solution. There will certainly be formed, as postulated by the crystal theory, a solution supersaturated with respect to a new solid phase and this solid phase will be formed sooner or later. Jolibois and Chassevent have already proved by the conductivity method that this occurs cor $CaSO_4 . 0.5H_2O$ and I have shown it for magnesium oxychloride cement by measurements of the viscosity changes according to the method of Ostwald and Wolski, though there was more fluid present in both cases than in real cements. Would it, therefore, be right to assume that supersaturation does not occur in the case of real cement mixtures as some supporters of the so-called colloid view say? quite wrong. Owing to the large extent of active surfaces in the case of real cements, we may suppose that supersaturation and consequently the recrystallisation of a new solid phase occur very quickly, in which case the above-mentioned gelatinous calcium sulphate is not in the form of $CaSO_4 . 0.5H_2O + xH_2O$, but is in the form of $CasO_4 . 2H_2O + yH_2O$ or $CaSO_4 . 2H_2O + yH_2O + z (CaSO_4 0.5 H_2O)$. So far the classical crystal theory does not offer any serious difficulies, but, if carried further, it fails to explain the phenomena and a new colloid standpoint comes into play. It must be remembered that the so-called colloid theory cannot here explain anything more because it denies supersaturation and recrystallisation. When a new solid phase appears from the supersaturated solution, surface hydration, somewhat according to my own term, takes place on the surfaces of very tiny crystal particles which may have colloidal dimensions. By surface hydration is meant a phenomenon whose true nature is obscure as yet, but which occurs quite frequently during crystallisation. Adsorbed water molecules on the surface possibly explain it, but in the case of magnesium oxychloride cement, Mg^{++} or Cl^- also can take part in the adsorption. But as the ions themselves are hydrated, water molecules here again play parts. In the above example, I *have mentioned the surface hydration* on $CaSO_4 . 2H_2O$ with the form of $CaSO_4 . 2H_2O + yH_2O$. This recrystallisation accompanied by surface hydration means the beginning of setting of a cement because the free water becomes less by changing into th forms of water of crystallisation and adsorbed water, of which the latter plays an important role in the viscosity relation. Here the crystals formed are not effective for setting by themselves, but through water. According to my view, the adsorbed water acts like gelatin; in the setting of gelatin it is clear that no crystals play a role. My X-ray diffraction patterns obtained by the powder method, however, show clearly the existence of crystalline $3MgO. MgCl_2 . 12H_2O$ in hardened magnesium oxychloride cements; $3 MgO. MgCl_2 . 12H_2O$ is a new solid phase formed in recrystallisation, the composition being determined from my phase rule research. But the above fact does not prove the correctness of the classical crystal theory because crystals with colloidal dimensions may give a diffraction pattern. Surface hydration is very important for the strength of cements as adsorbed water films prevent brittleness. The adsorbed water reminds us of a thin water film between two glass plates.

Furthermore, my opinion is against the crystal growth or the perfection of imperfect crystals as the cause of hardening. Von Weimarn's precipitation laws are very full of hints for setting and hardening: it treats the crystallisation from a solution, the solubility and the amount of the crystals formed, the viscosity of medium, and so on. According to this theory, the general scanty solubility of the newly formed solid phase, the large amount of this phase, and the high viscosity of medium all postulate that the crystals formed in cement mixtures are very tiny, although they may form

large aggregates, and they can remain in the original tiny form for a very long time. But X-ray diffraction pattens taken at intervals will give a decisive answer to the above questions as to the perfection of crystals, for the patterns by and by will become clear if the perfection of crystal occurs. From my own X-ray research, it became clear that when the cement mixture contains a comparatively large amount of fluid it gives a clearer diffraction pattern than that of a mixture with less fluid. The so-called colloid theory can not obtain any support from von Weimarn's theory because it denies crystallisation from a solution.

Also from my own researches, it is clear that added chemicals and the change of surface properties of the solid part influence the rate of setting. According to my considerations, setting means the appearance of new solid phases, and therefore added chemicals and the change of surface properties of the solid part mean the change of the rate of formation of new solid phases; and the rate of formation of new solid phases is influenced by two factors : the rate of solution of solids into fluid and the rate of recrystallisation of new solid phases. In the case of magnesium oxychloride cement, the casual standing of magnesium oxide in the open air means the decrease of the rate of setting and also of hardness; this means the magnesium oxide became less reactive to the solution. Whether added chemicals affect the reactivity of the surfaces of solids or the rate of recrystallisation of new solid phases, I do not know clearly. Furthermore I suppose that the degree of surface hydration may also be influenced. Conductivity measurements will give some valuable information with respect to the effects of added substances and the change of surface.

According to my researches, hardening, which means the hardness increase without external change after setting, is a continuation of setting, and the loss of water to the external system is not important; the change of free water into the forms of water of crystallisation and adsorbed water, however, is very important for hardening.

Finally, I will discuss the functions of free water, water of crystallisaton, and adsorbed water. The first added fluid part in a cement mixture means the free water which is necessary for practical working. The free water then becomes water of crystallisation and adsorbed water by the recrystallisation process; this change is necessary to increase hardness, for the existence of the free water means a soft mass. To prevent brittleness, the adsorbed water is necessary, and interlocking crystals without adsorbed water make a brittle mass as magnesium oxide and water illustrate. From these considerations the setting and hardening of cements are not essentially different from the setting of gelatin or starch paste; with cements, however, a gelatinous mass is obtained through the crystallisation of tiny crystal particles from a solution with surface hydration on their surfaces. This means the necessity of both crystal and colloid ideas expressed in a new light.

SUMMARY.

1. I have studied magnesium oxychloride cement with special reference to its setting and hardening in order to clear up the mechanism of those phenomena.

2. The above studies led to the conclusion that neither the classical crystal theory nor the so-called colloid theory accounts for the true mechanism.

3. A theory was proposed which involves both crystal and colloid ideas : the crystal idea is necessary for recrystallisation from a solution, and the colloid idea, for the surface hydration of the new solid phase.

PORTLAND CEMENT INDUSTRY OF JAPAN.

(From *The Journal of the Society of Chemical Industry, Japan.*)

It is just half a century since Portland cement manufacture was started in this country. Like several other instances, the Imperial Government established the first factory in 1877 in Tokyo. It was transferred in 1890 to a company which became the present Asano Cement Co., the largest producer. There are now for the cement manufacture 34 factories owned by 24 companies with capacity of 22 million barrels (a barrel equals 170 kg.) of annual production. The actual production in 1926 was more than 18 millions. For the following information about the present state of the industry of this country much is due to Prof. S. Nagai, of the Tokyo Imperial University.

Firstly, dealing with raw materials. There is not much difficulty here to find a sufficient amount of limestone of good quality, and the hard variety is generally used. Among the special calcareous material now used is to be mentioned calcium carbonate in form of black waste which is produced in the lime-nitrogen factory working for sul

phate of ammonia. This method of disposing of the residue was first tried in 1915 with success, and it has since become the usual practice.

As siliceous material, clay is most common, next comes shale. Some factories use ganister, quartz sand or a residue which is produced from alunite when alum is extracted from it. Pyrite cinder from sulphuric acid factory is often used for the supply of oxide of iron, and at times, iron sand or red clay or the same purpose. The incorporation of coal ashes produced in the factory as ingredient of raw mix is rather common practice.

As for gypsum, some prefer the imported material from Germany, France or Italy, on the ground that the home material are often of inferior and less uniform quality, although in majority of cases the latter is used. Waste of gypsum moulds of pottery or waste calcium sulphate from acetic acid manufacture are used in special cases.

It is long since the shaft kilns were abandoned here, and the rotary kilns are exclusively used, the largest ones now being used are 200 feet long with a diameter either of 9 or 10 feet. One 260 feet long and 12 feet in diameter is under construction. The dry process is common, but a few works use the wet process.

For the grinding of raw materials and clinker, ring roll mills, Kent mills, hammer mills, pendulum mills and hard mills are now obsolete, tube and ball mills are still common, but the nse of compeb mills or a similar one with many chambers in combination with air separators, are becoming most common, the largest compeb mills being 24 feet long and 7 feet wide.

Formerly the grinders, rotary kilns or driers were all imported from Germany or the United States, now it is not seldom to see the use of those made in this country.

Powdered coal is the only fuel used here for the kilns, neither petroleum is so cheap, nor the natural gas so abundant as to be available for the purpose.

Recovery of power by means of waste heat boilers and turbo-generators is usual, and the electric precipitation of dust is used in several works, the treaters being Cottrell or Oski type.

The quality of product has been improved year by year, especially after the World War. The standard specification for the testing of Portland cement was issued from the Government first in 1905, and it was revised in 1913, 1919 and in April this year on the recommendation of the Japanese Portland Cement Association. Prof. Nagai has tested several samples taken from the market, 8 kinds in 1926 and 12 in this year, the average results of which are given below. Although it is no doubt hard to say that this is the strict average of the total commercial products, it may be taken as fairly representative.

Special cements that may be mentioned are : a slag cement made of blast murnace slag of the Government Iron Works at Yawata, Fukuoka, and a "soliditit" manufactured according to an Italian patent process.

		Tensile strength kg/cm^2			Compressive strength kg/cm^2	
		7 days	28 days		7 days	28 days
Standard specification		>14	>21	—	—	>210
	2 days			2 days		
1926	19.7	27.0	33.2	188	338	435
	3 days			3 days		
1927	26.3	28.7	32.3	329	437	531

GENERAL NOTES.

BIRKBECK COLLEGE (LONDON) 104TH ANNIVERSARY.

The 104th anniversary of the foundation of the Birkbeck College was celebrated on Wednesday evening, December 7, by a large gathering of students and their friends at the College, Lord Haldane, president of the College, being in the chair.

Dr. George Senter, the Principal, presented the report, showing the steady progress of the College, which now forms part of the University of London. The number of students was in advaice of any previous year. The total entry for the session was 1,242 (733 men and 509 women), as compared with 1,227 for the previous year.

The Foundation oration, " Landmarks in Education," was delivered by Sir Henry Hadow, Vice-Chancellor of the University of Sheffield.

WONDERS OF GAS.

Remarkable Appliances at Exhibition of Light and Heat.

The extraordinary progress in both gas fire and gas cooker design made within the past few years was demonstrated at the International Exhibition of Light and Heat, at the Central Hall, Westminster, from December 13-16, at the stand of a leading group of British gas appliance manufacturers (Radiation, Ltd.).

Here it was explained that heating by radiant energy possessed definite advantages over alternative methods when provided by convected heat. The modern gas fire on view was incandescent, and emitted some 70 per cent. of the energy as radiant heat. The energy emitted in the visible portion of the spectrum and in the near infra-red had a definite stimulative value - a fact recognised by those who had done research work on the subject. It was possible to increase the percentage of energy available in this region, and special attention had been paid to the attainment of this desirable result in the development of the gas fires shown. The hygienic efficiency of gas grates constructed on the injector-ventilator principle was also demonstrated.

Among the group's other exhibits was the new style of gas cooker equipped with the "regulo" automatic oven-heat controller. Other exclusive features of the cooker are the single oven burner with direct bottom flue outlet; special brass taps which compensate automatically for wear, and always remain gas-tight; oven shelves which are carried on projections on the smooth enamelled sides of the oven, and the low temperature cooking zone at the bottom of the oven.

THE SCIENCE LIBRARY AT SOUTH KENSINGTON.

The Science Library at South Kensington, S.W.7., is the National Library especially devoted to pure and applied Science, and forms part of the Science Museum. The Library is open practically without restriction, daily from 10 a.m., to 6 p.m. Admission is by ticket, to be obtained by application addressed to the Director. A single admission may be granted by the Keeper of the Library. The Library is being developed as a Central Institution for study and research by endeavouring to gather together as complete a collection as possible of the scientific literature of the world, and at the same time to render all the information in the books readily accessible.

The Library contains specialist collections of books from the earliest times on the various branches of science and technology, including, in addition to works printed in Great Britain, the more important scientific books published throughout the world. Its collections of Periodical Literature, which are exceptionally large and complete, include the Transactions of Societies, and the Bulletins, Monographs, Reports and other publications of Government Departments, Experiment Stations, Observatories, Research Laboratories, Universities and Scientific Institutions of all kinds, as well as independent Journals. Most of the older, and many of the newer, periodicals are represented by complete files, and the attempt is now being made to form a complete collection of scientific periodical literature. The total number of entire volumes in the Library at the present time is 178,000, and these are being increased at the rate of 9,000 volumes a year. The total number of periodicals is about 8,000. Photostat copies of articles, illustrations, etc., are supplied at low rates.

New books received are exhibited for inspection in the Reading Room for one month before being allocated to the bookshelves. The current parts of some of the more important periodicals are shown in 500 pigeon holes in the Reading Room.

The author and subject catalogues are on cards and are kept up to date by the intercalation of typed slips. The Subject Catalogue is very minutely classified by the Brussels Extension of the Dewey Decimal System and contains one or more entries of every book received, as well as of monographs, bulletins, reports, theses and important papers. From this it is possible to ascertain, at a glance, what information on a given subject is available in the Library.

In addition, a comprehensive subject-matter card-inder to papers in scientific and technical books and periodicals generally, has been organised to be used as a key to recorded information, and for the supply of lists of papers on given subjects. This index, which will soon include about one and a quarter million cards, is classified also according to the Brussels Extension of the Dewey Decimal Classification, so that all references to information on a given subject can be found in one place under a single classification number, and this number can be ascertained from the alphabetical index of subjects. The index will contain practically all published bibliographical notices

that are classified according to the Brussels system, together with others prepared in the Library; and as more bibliographical undertakings adopt this classification, their publications will be cut up and added to the index, which will thus become more and more comprehensive.

ESTATE OF PROFESSOR LIVERSIDGE.

The will has been proved of Professor Archibald Liversidge, F.R.S., of Fieldhead, George Road, Kingston Hill, Surrey, Emeritus Professor of Chemistry in the University of Sydney, New South Wales (1873-1908), who died on September 26, aged 79, leaving estate of the value of £46,128, with net personalty £39,197. He gives :—

£2,000 to the University of Sydney, New South Wales, for a scholarship.

£1,000 to Christ's College, Cambridge, for a scholarship; £500 for a research lectureship in chemistry and in the English language; and such books, prints, pictures and photographs as the Master may select.

£1,000 to the Royal School of Mines for a scholarship; £500 each to the University of Sydney, the Royal Society of New South Wales, the Australasian Association (for the Advancement of Science of Sydney), the Chemical Society of London (for research lectureships in chemistry), the Marine Society (for the equipment and instruction of poor boys for the Royal Navy and Merchant Service), and the Church of England Homes for Waifs and Strays, and £500 to the Shaftesbury Homes and Arethusa Training Ship; £100 and his unpublished notes and papers dealing with chemical and scientific matters to the Chemical Society of London; and his medals and diplomas, and books, newspaper cuttings, prints, pictures, photographs and maps, the subject of which is Australia, to the Royal Society of New South Wales.

£100 each to Mary Campion, housemaid; Joseph Arthur Ormsby, gardener; and Reuben Creasy, chauffeur, if still in his employ; and an annuity of £52 to Sarah Reynold, housekeeper.

BOARD OF TRADE ANNOUNCEMENTS.

Safeguarding of Key Industries.

Exemptions from Duty.

The question of renewing Exemption Orders Nos. 1, 2, 3 and 4, which are due to expire on March 6, 1928, is now under consideration of the Board of Trade. The articles covered by these Exemption Orders are as follows :—

R Acetone, Acetone fermentation, Acetone synthetic, Acid oxalic, Amidopyrin, Ammonium perchlorate, Barbitone, Dial, Didial, Elbon, Ethylene bromide, Ethylene glycol, Furfurol, Glycol ethers, Guaiacol carbonate, Hydroquinone, Integrators (planimeter type), R Lead acetate, Lead tetra-ethyl, Lipoidin, Methyl sulphonal, Phenacetin, Phenazone, Phytin, Piperazine, Planimeters, R Potassium hydroxide, Potassium guaiacol sulphonate, Pyramidon-veronal, Salol, Sulphonal, Urea.

Any communications with respect to any of the above-mentioned articles should be addressed, before January 8, to the Principal Assistant Secretary, Industries and Manufactures Department, Board of Trade, Great George Street, Westminster, S.W.1.

Dyestuffs (Import Regulation) Act, 1920.

Applications for Licences in November, 1927.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during November ,has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 762, of which 639 were from merchants or importers. To these should be added 33 cases outstanding on the 31 October, making a total for the month of 795. These were dealt with as follows :—

Granted—693 (of which 662 were dealt with within 7 days of receipt).

Referred to British makers of similar products—70 (of which 32 were dealt with within 7 days of receipt).

Referred to Reparation Supplies available—2 (both dealt with within 2 days of receipt).

Outstanding on 30 November—30.

Of the total of 795 applications received, 728, or 88 per cent., were dealt with within 7 days of receipt.

CANADIAN MINE DEVELOPMENT.

Reuter's Toronto correspondent, cabling on November 30, reports as follows :—

An option of the Whitney (New York) interests on the Flin Flon Mine in North-West Manitoba, owned by the Mining Corporation of Canada, has been taken up by a cash payment of 854,000 dollars, the Mining

Corporation retaining 15 per cent. of the shares of the new company.

The Flin Flon gold, zinc and copper ores are estimated to aggregate at least 200,000,000 dollars. The development scheme planned involves a total expenditure of approximately 50,000,000 dollars. It includes the construction of a new railway line of 84 miles and a smelter with a daily capacity of 3,000 tons and a large water power development.

LITHIUM DEVELOPMENT.

According to a statement issued by the Industrial Development Board of Manitoba, the Silver Leaf Mining Syndicate intends to spend considerable sums on development work in the Province during the winter. A refining plant is being installed at Bradford, England, and lithia ore will be moved out on a larger scale during the next few months.

DEPARTMENT OF OVERSEAS TRADE.

ADDRESS OF BRITISH COMMERCIAL SECRETARIAT AT BERLIN.

The Department of Overseas Trade notifies that on and after 15th December the address of the British Commercial Secretaries for Germany (Mr. J. W. F. Thelwall, M.C., and Mr. C. J. Kavanagh) will be "Tiergartenstrasse 17, Berlin, W.10," and that all communications intended for those officers as from that date should be sent to the new address.

NEW CAPITAL ISSUES IN NOVEMBER.

According to statistics compiled by the Midland Bank, Ltd., new capital issues in November last amounted to £48,769,000, the highest figure for any month since March, 1920. The total for the past eleven months of the current year was £288,352,000, as against £308,515,000 in the corresponding period of 1926.

FURNISHINGS FOR PUBLIC HALL IN SOUTH AFRICA.

H.M. Senior Trade Commissioner in South Africa reports that the Town Council of Paarl, Cape Province, has accepted the tender of Messrs. Oosthuizen and Sterrenberg, of Noorder Paarl, for the construction of a new town hall.

It is suggested by H.M. Senior Trade Commissioner that United Kingdom firms interested in the supply of fittings, furnishings and seating accommodation for a small public entertainment hall may care to forward catalogues and price lists direct, or through the agents, to either the Town Clerk, Paarl, or to the contractors named above.

MERCHANDISE MARKS ACT.

REFERENCE TO STANDING COMMITTEE.

Copper Plates, Sheets and Strips and Wire, Shaving Brushes, Sheet Lead and Lead Pipes, Cast Iron Enamel Baths.

In accordance with the provisions of Section 2, Sub-Section (4), of the Merchandise Marks Act, 1926, the Board of Trade give notice that in pursuance of applications received by them for making of Orders-in-Council to require certain classes and descriptions to bear an indication of origin, they have made a reference to the Standing Committee appointed by them under the Act in respect of the following classes and descriptions of imported goods :—

(1) Copper plates, sheets, strips and other rolled sections; rods and wire (other than insulated wire);

(2) Shaving brushes of all descriptions,

(3) Sheet lead and lead pipes, including lead encased pipes and pipes known as compo pipes;

(4) Cast iron enamel baths of all descriptions.

Attention is called to the fact that, while, under the provisions of the above Act, the Committee must in every case referred to them consider whether the goods should bear an indication of origin at the time of sale or exposure for sale, they may also at their discretion consider and report upon the question whether such goods should bear an indication of origin at the time of importation.

Representatives of any interests substantially affected by any of the applications referred to in the above announcement, who desire to be heard in opposition at the public enquiry, which will be held later by the Committee, are requested to communicate with the Secretary, Mr. E. W. Reardon, at the New Public Offices, Great George Street, London, S.W.1., as early as possible, and in any case not later than 31 December, 1927.

THE FIRST-BORN.

Prof. Karl Pearson and other authorities hold that first-born children are more prone to tuberculosis, insanity and criminality than other children.

EUROPE'S SUGAR OUTPUT.

The latest estimates of sugar production in the various European countries are as follows:

	Estimate 1927-28: tons.	Actual Yield 1926-27: tons.
Germany	1,700,000	1,657,088
Czechoslovakia	1,265,000	1,031,489
France	870,000	705,126
Poland	620,000	562,790
Belgium	300,000	233,421
Italy	280,000	318,738
Holland	260,000	286,125
Spain	225,000	245,000
Hungary	175,000	175,086
Denmark	150,000	150,000
Sweden	145,000	20,871
Austria	105,000	79,686
Russia	1,400,000	988,000
Other countries	598,000	482,680
Total	8,093,000	6,925,000

BRITISH COLLIERY OWNERS' RESEARCH ASSOCIATION.

FORTHCOMING APOINTMENT OF TECHNICAL INVESTIGATOR.

STEEL SUPPORTS v. TIMBER UNDERGROUND.

The British Colliery Owners' Research Association (General Buildings, Aldwych, London, W.C.), is about to appoint a qualified mining engineer as technical investigator. His first work will be in connection with the use of steel supports in place of timber underground. Under suitable conditions the use of steel in place of timber may conduce to better results, and if the use of steel instead of timber can be adopted on a considerable scale, the use of British produced iron and steel in place of imported timber will not only be of very material benefit to the iron and steel industry but will help the coal industry also, by increasing the demand for coal for iron and steel production. A considerable amount of attention has already been devoted to this subject, and although in some cases the difficulties which have been experienced in connection wth the introduction of steel pit props have necessitated the reversion to timber, it is hoped that by a comprehensive survey of the experience of those who have succeeded in obtaining improved results from the use of iron and steel supports, and a study of the modifications in practice which are necessary to meet particular working conditions it will be possible to secure a much wider use of iron and steel in place of timber supports.

Proceedings and Notices of Societies.

THE ROYAL SOCIETY.

The following papers were read at the meeting held on Thursday, December 8.

The Magnetic Properties of Single Crystals of Nickel. By W. SUCKSMITH, H. H. POTTER AND L. BROADWAY. Communicated by A. P. Chattock, F.R.S.

The magnetic properties of single crystals of nickel have been examined in the principal crystal planes. The component of magnetisation parallel to the field was measured by the induction method, whilst component perpendicular to the field was measured by a torsion method. The reason for the use of the induction method is given in Part II of the paper, in which it is shown that the existence of directional properties in the crystal invalidates the use of the torsion method for the measurement of the parallel component.

The magnetisation and field coincide along the directions of the symmetry axes, the direction of easiest magnetisation being along the trigonal axis.

On the Second Approximation to the "Oseen" Solution for the Motion of a Viscous Fluid.

In 'Roy. Soc. Proc.,' A, vol. 113 (1926), the author applied Oseen's approximate equations of motion for a viscous imcompressible fluid to the calculation of the forces experienced by a cylindrical obstacle in a stream of such fluid.

The object of the present investigation was originally to obtain results of a like nature for the torque on the obstacle. It was found that this necessarily involved retaining terms of the second degree in the velocities, which had been neglected in the previous investigation, and this led to the consideration of the second approximation to the equations themselves.

This second order of approximation is obtained in the usual manner as follows:—We start from the "Oseen" solution as the "first order" and substitute this first order solution into the terms previously neglected in the exact equations of motion (restrcted, howeved, to steady motion). We then obtain integrals of the modified equations.

It is found that the new solution contains a certain term in which log r appears as a factor, r being the distance from the obstacle. This term, when the torque on the cylinder is calculated, leads to a result logarithmically infinite. It is verified that

this is the only term which does this, and it affects only the torque. The force resultants remain finite and the expressions obtained for them from the "Oseen" solution remais unmodified.

A Theory of the Optical and Electrical Properties of Liquids. By C. V. RAMAN, F.R.S., AND K. S. KRISHNAN.

A review of the experimental evidence shows that the existing theories of the refractivity and dielectric behaviour of liquids are inadequate to explain all that is known concerning the changes of these properties with density and temperature. A new theory is accordingly developed in this paper which is based on the idea that the molecules of the fluid are optically and electrically anistropic, and that, in addition, the polarisation field acting on a molecule in a dense field varies with its orientation relatively to the external field. The theory offers an immediate explanation why in general an *increased* density causes a *diminished* molecular refractivity as calculated from the Lorentz formula. It is shown that these changes in refractivity and dielectric constant are closely related to a change in the effective optical or electrical anisotropy of the molecules produced by the influence of its immediate neighbours. Similar ideas have been adopted in theories of electric birefringence and of light-scattering in liquids developed by the authors, which have found strong experimental support, and with the aid of which the anistropic constants appearing in the formulæ of the present paper can be evaluated.

The Solubility of Hydrogen in Silver. By E. W. R. STEACIE AND F. N. G. JOHNSON. Communicated by A. S. Eve, F.R.S.

The solubility of hydrogen in silver has been investigated from 200° to 900° C. at pressures from 5 to 80 cms. The solubility first becomes appreciable at 400° C. The solubility increases exponentially with increasing temperature. It is proportional to the square root of the pressure.

A mechanism has been suggested for the absorption of gases by metals, and the connection between absorption, adsorption, and diffusion has been discussed.

The diffusion of hydrogen throuh quartz has also been measured from 200° to 900° C. It has been shown that the assumption that the diffusion of hydrogen through quartz is of a mechanical nature is in accord with the observed facts.

Spectrophotometric Observations on the Growth of Oxide Films on Iron, Nickel and Copper. By F. H. CONSTABLE. Communicated by T. M. Lowry, F.R.S.

A spectrophotometric study has been made of the light reflected from thin films of oxide of successively increasing thickness formed upon cylinders of metallic and activated copper, nickel and iron.

It was found that the reflecting power of the metallic films increased considerably on activation, and that this increased power of reflection was sufficient to explain the brightening of the oxidation colours consequent on the oxidation of the metal. The phenomenon was imitated by oxidising a cylinder of metallic copper divided into four portions, burnished, sandpapered, and two electrolytically deposited. The brightness of the respective colour sequences were in the same order as the brightness of the metal surface on which they were produced.

The colour sequence on copper showed strong reds and weak blues. This was attributed to the strong specific reflection of red light by metallic copper. The sequence of nickel was remarkable for the absence of red colour, only browns being visible, while the dark blue was of remarkable intensity. The effect was attributed to the specific absorption of nickelous oxide. The colours on iron were normal to blue, after which the absorption became so strong as to distort the sequence.

THE OPTICAL SOCIETY.

At the monthly meeting of the Optical Society on December 8, at the Imperial College of Science, a paper on "The Design of Reflecting Prisms," was read by Instructor Captain T. Y. Baker, R.N. The author pointed out that in the majority of cases where reflecting prisms are used in optical systems there are nearly always great points of similarity of design. Reflections most frequently take place at angles of 45° with the surface; the planes of successive reflections are either the same or at right angles to one another. The reason seems to be that the designer-draughtsman has limited himself to these simple angles because they are easy to portray in plan and elevation on a drawing board, and that he has found himself debarred from using other systems through want of a practicable technique.

Captain Baker showed that any angles of incidence, and any alterations in the plane of reflection can be dealt with by the construction of a spherical diagram which ca

either be drawn with ordinary drawing accuracy on the surface of a sphere and then utilised to measure the various angles of incidence, etc., or if constructed more roughly, can serve as a diagram from which the various angles can be computed by spherical trigonometry.

From this diagram data can be derived which permit of the easy construction in wire of a model of the axial ray in its passage through the prism system. The next stage is to construct a wooden model of the full beam of light using for the purpose either a cylindrical or a slightly conical rod to represent the full beam when passing through the lens system without the prisms. This wooden rod can be cut in a manner that is prescribed by the spherical diagram and glued together again in an altered form. It then gives an exact representation of the passage of the full beam of light through the prism system. A further utilisation of the spherical diagram of a wooden model being made of a prism which will give the necessary reflections to the full beam.

Among the prism systems examined was that used in the prism binoculars. Captain Baker showed that the spherical diagram in this case is necessarily based upon the choice of two points, one on each of two great circles on the sphere mutually at right angles. The distance of those points from the point of intersection of the two great circles is absolntely at the designer's choice. With the customary system both those distances are 90°. With the Abbe and Sprenger prisms one is 90° and the other 60°. Apparently a systematic examination of the prisms that would result from the choice of other angles has never been made and the author suggested that if it were done possibly one might find a skew prism of compact form and without re-entrant angles that could be made in a single block of glass.

This communication was followed by an interesting discussion.

There followed a Demonstration of the "High-Frequency Interruption of Light (168,800 Cycles per. sec. by Piezo-Electric Quartz Crystal, by Mr. S. J. Underhill, of Messrs. Adam Hilger Limited.

This experimental apparatus was made at the suggestion of Professor Kerr Grant (see *Nature*, October 22, 1927, p. 586).

A beam of light is made to fluctuate in intensity at radio frequency in synchronism with the piezo electric oscillations of a quartz crystal.

The piezo-electric crystal is mounted between crossed Nicol's prisms, so that when stressed it enables a pencil of light to pass through the system from a carbon arc. It is maintained in vibration by a valve, and the transmitted light pencil, narrowed by a slit after leaving the crystal, falls upon a mirror which rotate about a horizontal axis of 132 revolutions per second. The streak of light thus produced on a cylindrical translucent screen surronnding the drum was found to be divided into bands 1.5 mm. apart, and from these data the frequency of the light beam was calculated as 168,800 cycles per sec., or approximately double the frequency (84,500 cycles per sec.) of the crystal as measured by an absorption frequency meter.

Votes of thanks to Captain Baker, Mr. Underhill and Messrs. Adam Hilger were carried with acclamation.

NOTICES OF BOOKS.

A System of Qualitative Analysis for the Rare Elements. By ARTHUR A. NOYES. Professor of Chemistry, California Institute of Technology, AND WILLIAM C. BRAY, Professor of Chemistry, University of California. Pp. XII + 536. Price 21s. net. Macmillan & Company, London and New York.

This is a valuable scientific book, which deals in a practical manner with a subject which is seldom touched upon by authors. Not only does the book contain the results of some 30 years' research on the part of the authors, but this experience is supplemented by hints, suggestions and other helps of a goodly array of other scientific men, so that the results have behind them experience the value of which cannot be denied. The work is, like Ancient Gaul, together, or can be read and studied separately. It is sought (with success to provide the chemical analyst with a method of detecting the rare elements by as simple a process as possible; the second part of the work embodies the results of the research carried out by the authors and others, boiled down and given in practical form for the benefit of experimenters, students or general scientific readers. While the third part is intended to disclose many of the secrets of inorganic chemistry to students, and so help to prepare them for the important positions that are available for the assiduous and well-trained votaries of science. There are given helpful tables and appendices, with a full index. The work merits a place in any scientific library.

PUBLICATIONS RECEIVED.

U.S. Geological Survey.

Surface Water Supply of the United States, 1923. *Part VI. Missouri River Basin.* Price 50 cents. *Part X. The Great Basin.* Price 25 cents.

Ground Water in the Ordovician Rocks near Woodstock, Virginia. By George M. Hall.

The Toklat-Tonzona Region. By Stephen R. Capp.

Geological Investigations in Northern Alaska. By Philip S. Smith.

U.S. Bureau of Standards.

Circular 333. *Specifications for the Manufacture and Installation of Two-Section, Knife-Edge Railroad Track Scales.* Price 10 cents.

Technological Paper 348. *Tarnish-Resisting Silver Alloys.* By L. Jordan, L. H. Grenell and H. K. Herschman. Price 15 cents.

Circular 333. *Specification for Leather, Rigging.*

Circular 340. *Specification for Leather, Hydraulic Packing.*

Circular 342. *Specification for Tile, Hollow, Clay, Loadbearing Wall.*

Scientific Paper 556. *Current Distribution in Supraconductors.* By F. B. Silsbee. Price 10 cents.

Technological Paper 344. *Comparison of American, British and German Standards for Metal Fits.* By Irvin H. Fullmer. Price 10 cents.

Scientific Paper 555. *A Weight Burette for the Micromeasurement of Liquid Volumes.* By Martin Shepherd. Price 5 cents.

Scientific Paper 557. *A Suggested New Base Point on the Thermometric Scale and the Inversion of Quartz.* By F. Bates and F. P. Phelps. Price 5 cents.

FORTHCOMING EVENTS.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

36, George Street, Manchester.

January 3, 1928.—" Young Peoples."

ROYAL SOCIETY OF ARTS.

John Street, Adelphi, London.

Dr. Mann Juvenile Lectures.

Under the Dr. Mann Trust, Professor Arthur Smithells, C.M.G., D.Sc., F.R.S., Director, Salter's Institute of Industrial Chemistry, will give two lectures for children on " Flame," at 3 p.m., on Wednesday, January 4 and 11, 1928. The lectures will be fully illustrated by experiments.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

32,308.—Chemische Fabrik Pott & Co.—Process or production of viscose. *November 30th.*

32,430.—Frischer, H.—Concentration of nitric acid. December 1st.

32,264.—Goldschmidt, S.—Process for oxidation of alcohol. November 30th.

Hubsch, M. G.—Process for removal of phenols from tars, etc. November 28th.

Specifications Published.

280,972.—Dreyfus, H.—Manufacture of acetic anhydride.

281,035.—Wallace, W. M., and Gregor, J. M.—Recovery of soda from its solutions.

281,114.—Barnard, C. M., and British Alizarine Co., Ltd. Caps and like head coverings.

271,881.—Frischer, H.—Methods of producing volatile inorganic acids.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

279,095.—Hydrocarbons.—Corson, M. G., 8108, Polk Avenue, Jackson Heights, New York, U.S.A.

Acyclic and cyclic hydrocarbons; hydrogenized organic compounds, catalytic production of. Hydrocarbons are obtained by reacting calcium carbide with an alcohol, phenol, or chlorine derivative of a hydrocarbon in the absence of carboxyl groups, at 150-300° C. and about 12-40 atmospheres pressure. When ethyl alcohol is employed, any water present is first decomposed, giving acetylene which is withdrawn through a reflux condenser. The condenser is then removed and the vessel closed, when diethyl-acetylene is formed, which may be further treated with hydrogen and a suitable catalyst under pressure to produce hexane. In another example monochlorbenzene is employed, yielding diphenyl-acetylene (tolane) which may be treated with hydrogen and a catalyst to produce stilbene or di-

benzyl. The dibenzyl may be treated with an active reducing metal such as zinc, magnesium, sodium or aluminium and hydrochloric acid to produce toluene. Methyl *alcohol*, propyl *alcohol*, *phenol*, *cresol*, and " benene dipchloride " may be reacted with calcium carbide in a similar manner.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

BITRATED.

458,398.—Chemical substances prepared for use in medicine and pharmacy.—International Chemical Co., Ltd, The Factory Braydon Road, London, N.16 December 7th.

BITRATE.

485,399.—Chemical substances prepared for use in medicine and pharmacy.—International Chemical Co., Ltd., The Factory, Braydon Road, London, N.16. December 7th.

THYLOX.

483,276.—*Chemical substances for use in* the purification of gas.—Koppers Products Company, Union Trust Buildings, Pittsburgh, State of Pennsylvania, United States of America. December 7th.

482,126.—Illustration of the Tower of London for all goods in class 3 which includes chemical substances prepared for use in medicine and pharmacy.—Charles Billing, trading as The Tower of London Soap Company, Clegg's Hotel, The Green, Hampton Court, Middlesex. December 7th.

JUST PUBLISHED.

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STELLAR ENERGY, RELATIVITY, GRAVITY, ÆTHER, PHOTO-ELECTRIC EFFECT.

By F. H. LORING.

(*Continued from Page 393.*)

There is a well-known surface-tension experiment that will serve to illustrate the idea of making the *total* curvature a minimum.

Take a small hoop, made of roughened wire, about three inches in diameter, and, with a good soap solution, form a film across it by simply dipping the ring momentarily into the solution.

Take a few inches of fine sewing silk and join the ends so as to make a closed loop. Wet this loop with the solution; then lay the loop gently on the film, its plane being horizontal.

The contour of the loop may be quite irregular, representing a good deal of curvature, and there will be no tendency for its shape to alter; but upon breaking the soap film within the loop by piercing it with a hot needle, the loop instantly assumes a perfect circle, thus representing a minimum of curvature.

Now *general* relativity involves a *space-time* conception that may in some way be translated into the æther under some sort of tension; but is *tension* the best word to use?

It is easy to make a false step here, and *like several of the words used in this article* they must not be taken invariably in the literal sense. For example, in speaking of the atom, this does not always exclude the electron and its counterpart, the proton, for these electrical entities, whatever they may ultimately turn out to be, *are essentially atomic*. Similarly, in speaking of lines of force, the term can be translated into tubes of force, ribbons of force, or linear extension of force, according as the context may suggest. In this connection the word *force* might be objected to on some grounds, but it stands for a class of phenomena pretty well understood. The words are so chosen as to place the idea into the best representative class realising that by so doing an idea is narrowed down within certain reasonable limits.

In speaking of *c* as a spreading constant, the inherent nature of radiation is made more evident.

In the theory of relativity this constant is a limiting one for no velocity can exceed *c*. Why is this so? Is it because when any

movement reaches the value of *c* spreading takes place? If this were true, then bullets fired from a strong enough gun with sufficient force behind them would spread when their velocity reached that of light. An impossible experiment, but the mind can easily extend the experiment beyond the practical limit; but the *spreading* is a difficulty.*

This spreading idea calls to mind an attempt the writer made many years ago to reconcile the fourth dimension with this sort of effect (see *Chemical News*, 1915, cxii, p. 100, second column).

Minkowski in his classical paper on relativity in which the conceptions of time by itself and of space by itself were forbidden, sought to avoid the emptiness of space by defining the velocity of light (*c*) as the ratio of the electro-magnetic to the electrostatic unit of electricity. This is, of course, a recognised relation.

Sir Oliver Lodge, in his article on the *æther* in the *Encyclopædia Britannica*, 1926, *Supplementary Vol. I*, says: "What we do know is that light is an electro-magnetic phenomenon, and that it is entirely dependent on the properties of the æther. The æther involves or possesses properties expressible by two fundamental constants; one of them regulates the force of attraction between two electrified bodies, and the other the force of attraction between magnets. Neither constant by itself is yet known. But the value of the constants multiplied together is known: it was discovered by Clerk Maxwell, and it is the reciprocal of the square of the velocity of light."

Oliver Heaviside, in his "Electromagnetic Theory," 1893, Vol. I., p. 462, says: "It would appear that we must go to the æther to find the source of all energy."

In order to unify the text, when quoting, the diphthong is used, since the writer prefers this spelling to make a distinction between the ether of space and the chemical substance by the same name. The above surface-tension experiment is compiled from the instructions given by Risteen in his book, "Molecules and Molecular Theory," 1895, p. 87.

(To be continued.)

* The relativity of time and space is supposed to assist in understanding the constancy of *c*, but here an attempt is made to translate matters a little differently.

LOW TEMPERATURE CARBONISATION.

Cold Blast Pig Iron to be Used for Retorts.

By A Well-Known Engineer.

In connection with the low temperature carbonisation at, say, 1000° F. of bituminous coal to produce a hard smokeless free burning fuel there has long been a difference of opinion as to whether it is best to construct vertical retorts, intermittent or continuous, of fireclay or cast iron. The latter has a number of obvious advantages, including a much better rate of heat transmission, ease of making any desired shape, including off-take pipes, man-hole covers, and supporting rings, and the fact that metal is air-tight and gas-tight, thus preventing leakage of gas into the flues and altering the temperature.

As against this, however, the objections to ordinary cast iron include a great tendency to oxidise and scale off under continuous heat conditions, even as low as 800-900° F., resulting in severe wear and tear, and the objectionable property of "creeping," that is permanent distortion in shape.

The "Coalite" process at Barnsley, now in this respect reverted to the original practice of Thomas Parker, the 'Tozer" process at Ballengeich in Natal, the "Hird" process, and the "E" retorts of the Fuel Research Board, are examples of the use of cast iron in spite of the troubles mentioned.

It is interesting to note that strong claims for low temperature retort construction are now being made on behalf of genuine cold blast pig iron. This is a speciality of Messrs. Robert Heath and Low Moor, Ltd., and it is maintained the well-known dense and tough character of cold blast iron, much superior to the ordinary hot blast iron, will overcome the difficulties of wear and tear. Naturally a product of this character using a cold blast of air in the furnace without any regenerator device costs a little more than hot blast pig iron because of the reduced thermal efficiency of the blast furnace, but slightly increased capital expenditure on a retort is a minor matter compared with the life, and the experiment will be watched with considerable interest.

Addenda.

In a footnote the writer says: The main point, as stated above, is that cold blast pig iron is known to be superior in quality to the ordinary pig iron with the hot blast, although naturally somewhat more expensive to make because of the reduced thermal

efficiency of the blass furnace. The theory is that because of these properties cold blast pig iron will give superior results for low temperature carbonisation retorts, and certainly the subject is of great interest, as cast iron has obvious advantages for retorts at say 1,000° F., but with the disadvantages in the case of ordinary iron of severe wear and tear and "creeping."

TYNDALL'S EXPERIMENTS ON MAGNE-CRYSTALLIC ACTION.

By Sir William Bragg, K.B.E., D.Sc., F.R.S., Fullerian Professor of Chemistry.

(Before the Royal Institution of Great Britain.)

In 1845 Faraday made the surprising discovery that the vast majority of substances, not merely iron, nickel, and cobalt, were affected by a magnet, and showed also that the action was repulsive quite as often as attractive.

Faraday's results excited the greatest interest, and were the starting point for many other researches. In fact, they paved the way for the work of Thomson and Maxwell, who came thereby to the establishment of the laws of electro-magnetism. Among the many workers who followed Faraday was Tyndall, who made certain interesting discoveries relating to the behaviour of crystals in the magnetic field.

A very lively discussion sprang up as to the mode of interpretation of the new discoveries, particularly that of the so-called "diamagnetism." On the one hand, Faraday was satisfied that he could describe them in terms of his "lines of force": the majority, including Tyndall, referred everything to the existence of poles, magnetic and diamagnetic. Tyndall's experimental work, aud the consequences which he drew from it, were devoted to the support of these views. When Faraday's conceptions prevailed it became clear that Tyndall's interpretation, of his own experiments in particular, must have been incorrect. His collected account of his researches published in the well-known "Diamagnetism and Magne-Crystallic Action" never became a link in the chain of argument.

The recent analysis of crystal structure by means of X-rays throws some new light on those experiments of seventy years ago. We can see more clearly where Tyndall's conclusions were in error. But at the same time—and this has seemed to be of such interest that you might like to hear of it in the evening's discourse—the experiments of Tyndall are seen to be closely related to a modern research of immense importance, that of the effect of stress on the constitution and physical properties of materials. Let me tell you the story.

On the 13 of September, 1845, Faraday made one of his most important discoveries, that of a relation between magnetism and light. He found that when plane polarised light was made to traverse a piece of his "heavy glass" a borosilicate of lead, in a direction coinciding with that of lines of magnetic force, the plane of polarisation was rotated. He had thus been successful in showing that the action of a magnet did not require the co-operation of a magnetic substance such as iron for its manifestation, but might be directly connected with a substance of a different kind, namely glass, and a different activity, namely light. In the following months he tried to find some other connection between magnetism and this glass. He floated his glass on a liquid and tried whether he could move it by a magnet, without result. But on November 4 he succeeded in his search. "The bar of heavy glass 1¾ of an inch long and* of an inch square, was suspended by cocoon silk in a glass jar in principle as before, and placed between the poles of the last magnet. When it was arranged and had come to rest I found I could affect it by the magnetic forces and give it position. Thus touching diamagnetics by magnetic curves and observing a property quite independent of light by which we may probably trace these forces into opaque and other bodies as the metals," etc. "If 1 was the natural position on making the poles magnetic the glass swung into position 2 and on to position 3. If contact was united after 2 the tendency to 3 was diminished, *i.e.*, was less than if there was no current. If whilst swingiug contact of current was continued during vibration from 1 to 2 and broken from 2 to 3, then united from 3 to 2 and broken from 2 to 1 the bar was soon sent spinning round the whole circuit."

The word "diamagnetic" is here used to denote substances through which, on his views, magnetic lines were passing. It is not yet used as an antithesis to paramagnetic. His new result obviously gave him intense pleasure, and in following it up he was so pre-occupied that he did not even go to the meeting of the Royal Society on November 20, when his paper on the "Action of Magnets on Light" was read.

* Not filled in, but from other notes we know it was half-an-inch square.

We can easily repeat the experiment, using a piece of the same glass taken from the store left by Faraday. It is not the actual piece, No. 174, as he tells us in his notes, for this cannot be found. The glass turns slowly in the magnetic field, and its motions are obviously controlled by switching the current off and on. The glass tends to set itself *across* the lines of force running from pole to pole, not *along* the lines as a piece of iron would do. And obviously the effect is very small as compared with the violent movements of iron under the same circumstances.

The action may be described as a repulsion of the glass my the magnet, and sometimes the early workers on the subject constructed apparatus specially designed to show the repulsive effect more obviously, and to distinguish it from a mere turning action in a magnetic field, if indeed this could be done. We can illustrate this point, and at the same time the diamagnetism of bismuth by using a piece of apparatus constructed for Tyndall.

Faraday at first suggested that the diamagnetic effect was the antithesis of the ordinary magnetic effect. A piece of iron when placed between two poles became so magnetised that a south pole was developed upon it in that part which was nearest to the north pole of the inducing magnet, and vice versa. Faraday's suggestion that the diamagnetic substance developed north and south poles where a magnetic substance would have developed south and north respectively was taken to be a satisfactory explanation. It was the constant endeavour of later experimenters to express their results in accordance with Faraday's hypothesis: even when development had reached a stage some distance ahead of that described in the original (*Phil. Trans.*, 1846, p. 21).

Faraday was himself the first to feel doubts as to the satisfactory nature of his explanation. His early results could conveniently be described as showing an exact antithesis between two classes—where one was attracted by a magnet, the other was repelled; where one set itself in a certain direction in the magnetic field, the other avoided that direction as much as possible. It seemed proper to describe them as being in exact antithesis to each other, and the word diamagnetism was adopted as a means of expressing the experimental list.

In December, 1845 (Exp. Res., Vol. III., Series XXI., 2429), Faraday writes:—

"Theoretically an explanation of the movements of the diamagnetic bodies, and all the dynamic phenomena consequent upon the actions of magnets on them, might be offered in the supposition that magnetic induction caused in them a contrary state to that which it produced in magnetic matter—*i.e.*, that if a particle of each kind of matter were placed in the magnetic field both would become magnetic, and each would have its axis parallel to the resultant of magnetic force passing through it; but the particle of magnetic matter would have its north and south poles opposite, or facing towards the contrary poles of the inducing magnet, whereas with the diamagnetic particles the reverse would be the case; and hence would result approximation in the one substance recession in the other."

But even at that time his views were not firmly established; and we may repeat an experiment of his which shows the nature of the contrary influences that were impressing him. A small glass tube filled with a weak solution of the magnetic substance ,iron sulphate, sets itself axially between the magnetic poles. But if it is surrounded as it swings by a strong solution of the same substance it sets equatorially. The tube appears to be magnetic as compared to air, but diamagnetic as compared to the strong solution.

Might not, on this analogy, all substances and also air and vacuum be magnetic, reacting to the magnet in the same way, but to different degrees? And might not bismuth exhibit its peculiarities, not because it was in antithesis to iron, but merely because it was less magnetic than the air? Yet he writes as follows: "Such a view also would make mere space magnetic and precisely to the same degree as air and gases. Now though it may very well be that space, air and gases have the same general relation to magnetic force it seems to me a great additional assumption to suppose that they are all absolutely magnetic, and in the midst of a series of bodies, rather than to suppose that they are in a normal or zero state. For the present, therefore, I incline to the former view and consequently to the opinion that diamagnetics have a specific action antithetically distinct from ordinary magnetic action, and have thus presented us with a magnetic property new to our knowledge." (*Exp. Res.*, Vol. III., eries XXI., 2440, Dec. 1845). The extract describes his first-formed opinion.

The next important step is due to Plücker:—

"In 1847 Plücker had a magnet constructed of the same size and power as that described by Faraday, his object being to investigate the influence of the fibrous constitution of plants upon their magnetic deportment; while conducting these experiments, he was induced to try whether crystalline structure exercised an influence. The first experiment made by Plucker gave an immediate and decided reply. The investigation of the behaviour of several crystals led him to announce the following laws :—

"When any crystal whatever with an optic axis is brought between the poles of a magnet, the axis is repelled by each of the poles; and if the crystal possesses two axes, each of these is repelled with the same force by the two poles.

"The force which causes this repulsion is independent of the magnetism or diamagnetism of the mass of the crystal; it decreases with the distance more slowly than the magnetic influence exerted by the poles."

There is some truth in Plücker's conclusions, but much correction is necessary. Tyndall pointed out in 1850 that they broke down completely when applied to calcium and iron carbonate. These two crystals are isomorphous; the former, Iceland spar, obeys Plücker's laws in that it sets its axis equatorially in the magnetic field, but iron carbonate sets its axis from pole to pole. Plücker had, however, done great service in calling attention to the peculiar behaviour of crystals in the magnetic field.

In the autumn of 1848 Plücker was in London. Faraday writes in his laboratory notes :—

"16 Aug. 1848. Plücker has described to me certain of his results as to the crystalline diamagnetic relation and, as I understand it, the optic axis of a crystal having *one* optic axis tends to pass into the equatorial direction, or if a crystal have two optic axes then the line between them tends to pass into the equatorial direction."

"25 August. 1848. To-day Plücker showed me for the first time some of his experiments."

In 1848 Faraday published a series of researches on the magne-crystallic phenomena presented by diamagnetic bodies, when subjected to the forces in the magnetic field, might be accounted for by assuming that they then possessed a polarity, the same in kind as, but the reverse in direction of, that acquired by iron, nickel and ordinary magnetic bodies under the same circumstances. This view was received so favourably by Plucker, Reich and others, and above all by W. Weber, that I had great hopes that it would be confirmed; and though certain experiments of my own did not increase that hope, still my desire and expectation were in that direction. (2641.) Whether bismuth, copper, phosphorus, etc., when in the magnetic field are polar or not, is however, an exceedingly important question; and very essential and great differences in the mode of action of these bodies under the one view or the other, must be conceived to exist. I found that in every endeavour to proceed by induction of experiment from that which is known in this department of science to the unknown so much uncertainty, hesitation and discomfort arose from the unsettled state of my mind on this point that I determined if possible to arrive at some experimental proof either one way or the other. This was the more important because of the conclusion in the affirmative which Weber had come to in his very philosophical paper. . . . (2642.) It appeared to me that many of the results which had been supposed to indicate a polar condition were only consequences of the law that diamagnetic bodies tend to go from stronger to weaker places of action; others again appeared to have their origin in induced currents. . . "

Faraday, as I have said, when this thorough examination of the facts had led him to frame a hypothesis which would link them together, based his interpretation on the existence of lines of force, and found himself able to place both his own results and those of others in their place within a self-contained system.

Kelvin placed this hypothesis in mathematical form, thus completing the treatment of the subject of magnetism by Poisson; the latter had left out of his consideration the consequence of magnetic susceptibility being different in different directions, not because he overlooked the possibility of such an effect, but because no case of its occurrence was known to him.

But Faraday's views were not accepted by other experiments on the same subject, and it particular by Tyndall. The idea of polarity was not to be given up easily, and innumerable experiments were made to show that a "diamagnet" had poles like a magnet, but in the opposite sense. A bar of bismuth would develop north and south poles, when under similar circumstances a

bar of iron would develop south and north. And, of course, when the facts are prepared for mathematical treatment they can be expressed in this way. It is generally convenient and justifiable to represent a magnet by two poles because the form of the field at any reasonable distance is satisfactorily represented thereby, though in the immediate neighbourhood the lines of a real magnet do not run like those of the theoretical bipole. Within the body of the magnet the lines run from the south pole to the north, continuing and completing their course outside, so that every line is a closed circuit; but all lines near a bipole run from the north pole to the south pole. So also in the magnetic shell, which is in the mathematical treatment the exact analogue of the electrical condenser, the bulk of the lines run from one plate to the other across the narrow space between the two plates; comparatively few run from the outside of one plate, through surrounding space, to the back of the other. In the condenser the internal field is the more important, the external being looked on as a correction. In the magnetic shell the reverse is the case; the outside field is that which is considered because it represents more and more closely, as the plates are brought together, the field due to a current circulating about the contour of the condenser. The theoretical charges on the plates have to be made larger and larger as the plates are brought together so that the strength of the outside field may remain the same.

Now, if a piece of bismuth is placed along the lines of a magnetic field, the lines avoid the piece to some extent, though, as already explained, the avoidance is extremely small. If we take the bismuth away and replace it by a feeble bipole consisting of south pole magnetism, of proper amount, where the lines come out of the bismuth and a corresponding amount of north pole magnetism where they go in, the whole arrangement being made in a vacuum, or, permissibly, in the air, we get in this artificial way an external field resembling that which exists when the bismuth is in place It can be said that polarity is developed in the bismuth in a sense opposite to that which is to be found in iron under the same circumstances. If the effect is to be represented, for the convenience of treatment, as due to the presence of a bipole, then the sense of the bipole in the case of bismuth is opposite to the sense in the case of iron. The old argument therefore was not between two hypotheses but two languages in terms of which the facts were to be described. Such an antagonism, once believed in and debated, could be, and was, the cause of an immense variety of experiments devised to justify one side or the other. But Faraday felt that his way of putting the facts was more fruitful in suggestion of further experiments, and more convenient as a foundation for theoretical development. He has been abundantly justified.

We now come to the part which Tyndall played in a debate which was conducted on both sides in such an able, and, it is pleasant to observe, in such a friendly way. In the first place, Tyndall and Knoblauch published in 1850 an account of experiments which they had made. They showed that Plücker's first views, those which included the repulsion of the optic axis of a uniaxial crystal by the poles of the magnet were, as already stated, incorrect in many cases, and they substituted an amended set of rules in the following terms :-

"If the arrangement of the component molecules of any crystal be such as to present different degrees of proximity in different directions, then the line of closest proximity, other circumstances being equal, will be that chosen by the respective forces for the exhibition of their energy. If the mass be magnetic this line will set axial, if diamagnetic equatorial."

The key-word is "proximity." This condensed statement, of course, requires explanation. Tyndall supplies it in full in his book on "Diamagnetism and Magnecrystallic Action." A brief summary will be sufficient for our present purpose. In the first place, the observations made by himself and his partner on the behaviour of crystals in the magnetic field convinced them that the plane of cleavage determined in a number of cases the position which the suspended crystal would take. Magnesium sulphate, zinc sulphate, saltpetre, and topaz were diamagnetic substances, and their cleavage planes, the crystals being so suspended that these planes were vertical, always set themselves equatorially, *i.e.*, at right angles to the field. On the other hand, nickel sulphate, scapolite, and beryl, which were magnetic crystals, under the same circumstances set their cleavage planes parallel to the field. The connection between these results and the statement quoted above lies in this, that the molecules in a crystal were supposed to be in greater proximity along a cleavage plane than in any other direction. Let us take bismuth

as an example. It is diamagnetic and sets its cleavage plane equatorially in accordance with Tyndall's rule. Its structure has now been determined by X-ray analysis, so that we can see what meaning can be attached to the claim for proximity in the plane of cleavage. The bismuth structure can be looked on, approximately, as a slightly distorted cube; one of the cube's diagonals has been a little stretched, while the other three have been left unchanged. The crystal is then uniaxial; the axis is the stretched diagonal; *the principal cleavage plane is perpendicular to the axis. The spacing of the planes parallel to the cleavage is larger than that of any other set of planes in the crystal, and these consequently contain more molecules to the unit area than any other planes.* Tyndall would have said that in those planes there was a maximum proximity between the molecules.

The X-ray analysis of other crystals often shows the cleavage plane to have the largest spacing and therefore the closest degree of packing. This means that the points of the crystal lattice are closest together in that plane, but it does not mean that the atoms or molecules are nearer together in that plane than in any other. Nothing can be said about that until the actual distribution of the atoms in the unit cell has been determined. It would be much safer to say that the existence of a cleavage plane implies a certain *looseness of packing across* the crystal planes, which are parallel to the cleavage. This would imply a greater tightness in other directions, but not necessarily a greater proximity. It is only at first glance that the latter term seems to have a clear meaning. But we must let it stand in order to realise the argument as it presented itself to the authors of the statement quoted.

It happens that in the case of bismuth we do actually find a closer bonding between the atoms in the cleavage plane than in any other; but this is peculiar to the structure of bismuth, and has no relation to the supposed close proximity of *molecules* in the cleavage plane.

Now we come to the essential point of the argument. It is supposed that proximity offers magnetism or diamagnetism, whichever it may be, the oppotrunity to "exhibit its greatest energy." We are to remember that the hypothesis on which we are working expresses itself in terms of poles, and that a magnet attracts a piece of iron by inducing poles in it, which poles then react with the poles of the magnet, the poles induced in it are much stronger than if the magnet and the iron are separated by a little distance. If a second piece of iron is brought near the first, every increase in its proximity increases the strength of the poles which are developed in this piece by the influence both of the original magnet and of the first piece of iron. The nail hangs in the first case, and not in the second, because the close proximity of the iron blocks increases the strength of the poles in all of them. In the second case, the nail will not hang, although the magnet is actually closer to it. The benefit of mutual "proximity" of the separate pieces of iron is obvious. An equally simple explanation can be given in terms of lines of force, but we are using the alternative language.

We now come to another set of experiments, very interesting and important, which were used by Tyndall in the defence of the "polarity" position. The method of these experiments was suggested by an accident. When working in Berlin with a fine magnet placed at his disposal by Magnus he was observing the action of the magnet on a bismuth cube which was so shaped that two opposite faces were perpendicular to the optic axis and parallel to cleavage planes. When the current was switched on the magnetic poles rushed together because the separate parts of the magnet had not been properly bolted down. The bismuth cube was crushed to some extent. Working conditions having been restored, it was found that the bismuth set itself at right angles to its former position. The line of pressure, which of course had been parallel to the field, was now perpendicular to it. Tyndall now argued that the particles of bismuth had been brought into greater proximity by the pressure, and that the setting of this line of great proximity was in accordance with the rule given by himself and Knoblauch. So began an extended series of researches on the effects of pressure which are fully described in his book. As an example let us take the following :—

"A quantity of bismuth was ground to dust in an agate mortar, gum-water was added, and the mass was kneeded to a stiff paste. This was placed between two glasses and pressed together; from the mass when dried two cubes were taken, the line of compression being perpendicular to two o[f] the faces of each sube and parallel to th[e] other four. *Suspended by a silk fibre in th[e] magnetic field, upon closing the circuit th[e]*

line of compression turned strongly into the equatorial position . . ."

When carbonate of iron was used the line of pressure set axially.

Such an experiment is very striking; whatever its explanation may be. Tyndall argued that he had by compression increased the proximity along the line of pressure, but it is difficult to see how this can be. If a number of particles of one kind are distributed with complete irregularity in a paste medium which is then subjected to pressure in one direction, the alteration in form of the paste block will not alter the law of distribution of the particles. In any case, as we have already shown, proximity does not produce any observable effects.

It is surely natural to suggest that the particles acquired some orientation from the pressure, which might well happen, if they possessed shapes which were related in some particular way to their structures. Thomson immediately pointed this out to Tyndall, who replied that if that were the case, the bismuth fragments being naturally in the form of flakes parallel to the cleavage planes, the line of pressure ought therefore to set itself axially, whereas it actually set equatorially. This was certainly a good reply. Perhaps the counter argument is that the crystal fragments have not actually been shown to set in this way. Miss Knaggs has made an X-ray measurement of the set of the fragments in one specimen of squeezed dough containing bismuth particles and has found that the cleavage planes are not closely co-planer with the surface as they must be if Tyndall's argumen is to be good. Though this is a single example, it looks as if a way of escaping the difficulty was to be found.

As I have said, Tyndall's reply to Thomson was good, but, to use his own words, though it formed "a strong presumptive argument it was not yet convincing." He strengthened his case greatly by a further experiment. Comparing the repulsion exerted by a magnet on a natural crystal of bismuth with that exerted on a mass of compressed powder in dough he found the latter greater than the former. He had cut the crystal into the form of a cube and placed it on one arm of a torsion balance so that the cleavage plane was perpendicular to the magnetic field, and the repulsive force as great as it could possibly be. The dough had been pressed into a cube of the same size and placed with its line of pressure at right angles to the field. Tyndall argued that ther must be a direct effect of pressure, since it had done more than all that the natural phenomenea could do.

GENERAL NOTES.

OUR TRADE WITH ARGENTINA.

Pronounced changes of recent years in the nature and distribution of Argentine commerce call for a much closer study than formerly of the local aspects and conditions of mutual trade, writes Mr. H. O. Chalkley, C.B.E., British Commercial Secretary at Buenos Aires. We have the goodwill of the Argentines towards British goods to such an extent as to constitute a preference for a British article of competitive price, and we also have an unrivalled machinery of distribution. It is "up to" us to avail ourselves of these advantages to the full.

DIRECTION OF FRENCH TRADE.

Imports from Great Britain during the first ten months of the current year declined by 389 million francs as compared with the same period of 1926, while those from Holland, Spain, Argentina and Canada advanced. Exports to Great Britain declined by 331 million frs., while Germany, Poland, Sweden and Canada showed increases.

DEPARTMENT OF OVERSEAS TRADE.

COMMERCIAL SECRETARY AT RIO DE JANEIRO.

The Department of Overseas Trade announces with regret that Mr. E. Hambloch has resigned his appointment as Commercial Secretary (Grade I.) for Brazil on account of ill-health. His resignation took effect on November 16, 1927.

It has been decided to fill the vacancy by the appointment of Mr. S. G. Irving, at present serving as His Majesty's Consul at Lisbon.

BRITISH EXPORTS.

The outstanding feature of the Trade Returns for November is that Exports of British Produce and Manufactures reached a value of £70,610,000, a sum about £9,632,000 above the value of the corresponding exports in October and about £9,632,000 above the exports in November, 1925. Furthermore, they have not been exceeded in value in any month since July, 1924, when the figure was

£71,283,000; while in 1923 higher records were only made in May (£71,555,000) and in October (£71,323,000). Considering the much higher averages of export values that prevailed in 1923 and 1924 it is safe to say that the volume of exports of British Produce and Manufactures in November, 1927, is much higher than in any month since April, 1923, when exports to the Irish Free State were first included in our statistics of overseas trade.

WEIGHING LONDON'S FOGS.

More Air Impurities Despite New Anti-Smoke Act.

London's fogs for November have been officially "weighed," and it has been ascertained that the soot particles and the other impurities that make up a fog amounted on an average during the period to 1.18 lbs. per *million cubic yards.*

This figure, which was given to a press representative by Dr. J. S. Owens, Secretary to the Advisory Committee on Atmospheric Pollution to the Air Ministry, is derived from records taken in South Kensington. It shows a marked increase over the figure for the corresponding period of 1926, which was 0.86 lbs. *per million cubic yards*, and indicates that the new Smoke Abatement Act, which became operative on July 1 last, but which did not deal with the domestic coal problem, has had little influence on the smoke nuisance.

ANTIMONY DEPOSIT TO BE DEVELOPED IN NEW BRUNSWICK.

According to the *Canadian Mining Journal* of November 18, an entirely new process is to be installed for the recovery of antimony at the Lake George properties in New York, New Brunswick.

The new process employs a flotation method which has been tried out extensively in experimental tests and has given excellent results. In fact it is said that the new machinery which is to be installed will give a recovery of 97 per cent. of the stibnite which is contained in the ore. Previously there was a very large percentage of wastage and consequent losses; the installation of the new system will substantially enhance the financial return from the operation of the mines.

Ore is now being bagged for shipment, and it is expected that until the reduction plant has been installed there will be shipments of ore of considerable size to New York, New Jersey and elsewhere in the United States where there is a ready market for antimony ore. The mines are located within four miles of the Saint John Valley Railway, which is owned by the New Brunswick Government and operated by the Canadian National Railways.

THE ALUMINIUM PRODUCTS INDUSTRY IN CANADA, 1926.

According to a statement just issued by the Dominion Bureau of Statistics at Ottawa, the output of manufactured aluminium products in Canada during 1926 reached a value of $1,917,819. Twelve plants in Canada, all located in Ontario, were engaged in the manufacture of aluminium articles of various kinds. Capital employed by these concerns was reported at $3,930,336, of which $2,301,226 was the value placed on land, buildings, plant fixtures, machinery and tools. The average number of employees was 428; salaries and wages paid during the year totalled $554,024. Materials used in manufacture cost $801,835 delivered at the works, and the total selling value at the plants of all products made was $1,917,810. Kitchen utensils of all kinds were the main products; the total output in 1926 being worth $1,028,261 as against $1,056,920 in 1925. Seven plants made kitchen utensils and, of these, 5 were engaged solely in the manufacture of kitchenware while the other 2 concerns also made quantities of other aluminium articles including boot and shoe lasts, brush holders, bevel gears, valve caps and thermit. Imports into Canada of alumina cryolite ore and aluminium metal in the form of ingots, bars, tubing, household hollowware, etc., were worth $4,870,018 in 1926. Exports of aluminium in ingots, bars, etc., and in manufactured articles totalled $7,088,807 in value. Imports of household hollowware were valued at £268,286 in 1926, and exports of all aluminium manufactures in the same year reached a value of $1,188,260.

Proceedings and Notices of Societies

THE ROYAL SOCIETY.

Papers read at the meeting on December 8, 1927:—

An Experimental Study of the Motion of a Viscous Liquid contained between two Coaxial Cylinders. By J. W. Lewis. Communicated by H. C. Plummer, F.R.S.

A description is given of the apparatus in which suspended particles are used to follow the motion of a viscous liquid between two cylinders.

Mathematical laws deduced by G. I. Taylor for the case when ratio of interspace (d) to radius (R_1) of the inner cylinder is small have been confirmed.

When the outer cylinder is fixed, the expression for the critical velocity at which the laminar motion gives place to vortex motion is found to hold for values of the ratio d/R_1 as high as 0.71, and for liquids whose coefficient of viscosity varies from 0.006 to 0.018 C.G.S.

When the outer cylinder is fixed, the determination of the critical speed can be used for the measurement of viscosities. When $R_1 = 0.26$ cm., and $R_2 = 0.45$ cm., viscosities from 0.008 to 0.012 C.G.S. can be measured with certainty to within 1 per cent.

If, when vortex motion has set in, the speed of the cylinders is reduced, then the motion reverts to the laminar state at a critical speed, which is fixed for given dimensions and liquid. This critical speed is definitely lower than the critical speed given by Taylor's formula.

The upper and lower critical speeds tend to become equal as the ratio d/R_1 is decreased. When d/R_1 is large, spacing of vortices may vary within fairly wide limits, though there is no such large variation in the speed at which vortices set in.

Passage of a Locomotive. By C .E. Inglis. Communicated by Sir Alfred Ewing, F.R.S.

Mathematical methods are developed for predicting the state of oscillation set up when a given locomotive crosses a bridge at a specified speed. The author, as a member of a Committee appointed in 1923 by the Department of Scientific and Industrial Research to investigate impact effects in railway bridges, has enjoyed the advantage of having the results of practical experiment to point the way.

Analysis is applied in the first instance to a long-span bridge where the state of oscillation is not sufficiently violent to stimulate spring movement in the locomotive. The necessity of taking into account the damping influences in the bridge and the variation in its natural frequency caused by the mass of the locomotive is illustrated by cases in which these factors have not been included.

A more comprehensive analysis, in which bridge damping and inertia effects of the moving load are taken into account, is applied to the case of an actual bridge of 262½ feet span, tested by the Bridge Stress Committee, and very good agreement between theory and experiment is obtained at all speeds.

Laboratory experiments with a model bridge and locomotive are described. The use of this model for predicting the oscillations in an actual bridge is suggested, and a further check on validity of the analytical theory is indicated by a deflection record obtained from the model bridge.

Tides in Oceans on a Rotating Globe. By G. R. Goldsborough. Communicated by T. H. Havelock, F.R.S.

A method is developed by which it is possible to calculate the forced tidal oscillations in an ocean, bounded by two meridians, on a rotating globe. When the ocean depth is proportional to the square of the cosine of the latitude the determination of the semi-diurnal tide is slightly simpler, and it is with this particular case that the paper is largely concerned.

The method does not allow the determination of the free periods of oscillation, but it does (in the case of the stated law of dpth) permit of the determination of the critical depths at which synchronism with the semi-diurnal tide takes place. It is shown that in an ocean bounded by two meridians 60° apart (which may be regarded as a representation of the Atlantic Ocean) the critical depth is not far from the mean depth of the Atlantic Ocean. The tides of that ocean may then be considered as arising from approximate synchronism. For the purposes of illustration a case with arbitrarily chosen depth is fully worked out.

While the case dealt with in the paper is that following a special law of depth, the method is capable of generalisation and extension to other forms, in particular to oceans of uniform depth, and to all types of tide-producing force.

The Fit of a Formula for Discrepant Observations. By W. F. Sheppard. Communicated by E. T. Whittaker, F.R.S.

For testing whether a set of observations is consistent with a particular hypothesis, the accepted method is Pearson's "χ^2" method, published in 1900. The discrepancies between calculated and observed values being found in the usual way, the extent of agreement is summarised in a ratio P, which is, broadly speaking, the relative frequency of occurrence of similar or greater discrepancies in cases of the kind we are considering. The formula for P is correct when

the hypothesis is completely formulated *a priori*. But, when the hypothesis involves unknown constants which have to be determined from the observations themselves, the formula is not exact, since it does not allow for the fact that in so determining the constants we have to some extent adjusted the data to meet the hypothesis. The present paper deals with the correct formula for these cases, working to the order of small quantities.

If there are k constants in the hypothesis, and m observed quantities, the m discrepancies are connected by k relations. The formulæ for these are given. In consequence of these relations, only $m - k$ discrepancies will be involved in the formula for P.

The important theorem is that, whatever (correct) method we use for finding the constants and thence deducing the discrepancies, we arrive always at the same value for P. This is the result of linear relations between sets of discrepancies found by different methods. Suppose that by one method we arrive at a set of discrepancies θ_1, θ_2, . . . θ_m, and that by another method we arrive at another set of discrepancies, one of which is ϕ_r. Then ϕ is the same linear function of the θ's that it is of the true errors to which θ's respectively correspond.

SOCIETY OF PUBLIC ANALYSTS.

An ordinary meeting of the Society was held at the Chemical Society's Rooms, Burlington House, on Wednesday, December 7, the President, Mr. E. Richards Bolton, being in the chair.

Certificates were read for the first time in favour of :— George Reginald Barnes, B.Sc.; Cecil Abell Bassett, B.Sc., A.I.C.; Ethel Irene Beeching, M.Sc., A.I.C.; Harold Pease Buttrick, A.I.C.; Cecil Owen Harvey, B.Sc., A.R.C.S., A.I.C.; Harold Vivian Horton, B.Sc., A.I.C.; Thomas Howard, M.Sc., A.I.C.; Harold McKee Langton, M.A., B.Sc., A.I.C.; William Alfred Nottage Markwell; Walter George Messenger, B.Sc., A.I.C.; Edward John Newby, B.Sc.; Horace Samuel Rooke, M.Sc., A.I.C.; Claude Trevine Symons, B.A., F.I.C.; David Rees Thomas, M.B., Ch.B., S.Sera; and Wilfred A. Whiteley.

Certificates were read for the second time in favour of :— Alfred Harry Bateman, B.Sc., A.I.C.; Arthur Owen Blackhurst, M.D.; William Clayton, D.Sc., F.I.C.; Charles William Cornwell, B.Sc., A.I.C.; and Thomas Riley, A.I.C.

The following were elected Members of their Society :—Leslie V. Cocks, A.I.C.; Frederick Dixon, B.Sc., A.I.C.; David Michael Freeland ,A.I.C.; Desmond Geogehan; Claudius George Hyde, A.H.C.S., F.I.C.; Vernon James Tilley, F.I.C.; Leonard Wild, B.Sc., and Hugh A. Williams.

Demonstrations were given by G. W. Monier-Williams, O.B.E., Ph.D., F.I.C., of an apparatus for determining Benzoic Acid in Foods and by T. McLachlan, F.I.C., and A. W. Middleton, of a Sodium Flame for Polarimetric Work.

The following papers were read and discussed :—

Oil Bromide Films and their Use in Determining the Halogen Absorption of Oils. By HAROLD TOMS, M.Sc., A.I.C. (Work done under the Analytical Investigation Scheme.)

Oil films exposed to an atmosphere of bromine absorb the halogen quantitatively, and, after removal of the excess of bromine at a low temperature, the bromine absorption can be determined gravimetrically. The method, which gives accurate results with 20 to 50 mgrms. of an oil, has been used to determine the composition of the insoluble bromide of linseed oil, after removal of the bromine, by prolonged treatment with nascent hydrogen. The iodin values, calculated from the bromine absorbed, agree with those obtained by th Wijs method, except in the case of tung oi the gravimetric bromine absorption which stands in a constant relationship t the iodine value. The brominated films several oils (linseed, menhaden, soy perilla, etc.) show characteristic differenc in appearance.

Tests for Impurities in Ether. I. Tes for Peroxides. By G. MIDDLETON, B.Sc A.I.C., AND F. C. HYMAS, B.Sc., A.I.C.

Only organic peroxide (probably dih droxydiethyl peroxide) is to be expected ether purified for anæsthesia. The sen tiveness of the various tests for peroxi (which renders the ether less stable, is co pared, and two new tests are describ The ferrous thiocyanate test is reco mended for official adoption, and a colo metric limit for the amount of peroxide proposed. An improved method of prep ing the ferrous thiocyanate reagent is scribed, and it is shown that the test, wh gives no coloration with pure ether, is too stringent for practical purposes.

Arsenic in Coated Papers and Board. By H. J. Stern, B.Sc., Ph.D., F.I.C.

In general, uncoated papers and boards, and the adhesives used, are unlikely to contain a dangerous amount of arsenic. Mineral pigments are also usually satisfactory, but some of the synthetic inorganic pigments may be dangerous. Thus, a paper coated with an arsenical green may contain over 6 grms. of arsenious oxide per square metre. Some of the lakes of synthetic dyes, notably magenta and methyl violet, precipitated with arsenious oxide contain dangerous amounts of arsenic (e.g., 40.5 per cent. of As_2O_3). Certain dyes, notably Pigment Scarlet 3B and Orange II, may contain 50 to 100 parts of arsenic per million. A provisional arrangement is in force among the users of pigments for this purpose limiting the amount of arsenic to 10 parts per million, and the boards in use seldom contain more than 2 or 3 parts per million.

THE PHYSICAL SOCIETY.

The following papers were read at the meeting on November 25, 1927, held at the Imperial College of Science, London.

Regularities in the Spectrum of Ionised Neon. By P. K. Kichlu, M.Sc.

In a previous paper on the same subject, the author traced a system of quartet terms in the known spectrum of ionised neon. In the present paper the theory of Hund is applied in tracing doublet terms and intercombinations between doublets and quartets. Almost all the lines between 2,500 and 3,800 have been accounted for, with a few discrepancies.

A Calorimeter for the Determination of the Heat Developed by Fruit. By Ezer Griffiths, D.Sc., F.R.S.

A calorimeter for measuring the heat evolved by apples during the senescence stage is described. A differential arrangement is used, one container being filled with apples and the other with dummy apples of the same thermal capacity, made of thin-walled glass spheres filled with moistened glass wool. These containers are enclosed in a metal box thermally insulated, and set up in a constant temperature room. Resistance thermometers composed of 80 yards of nickel wire in glass tubes are disposed among the apples and the dummies. They are connected differentially to a slide wire, on which a difference of one thousandth of a degree causes a movement of the contact maker of 3 millimetres. The air circulation is controlled so as to maintain at will atmospheres containing from 2 to 10 per cent. of CO_2 around the apples. The moisture content of the air before and after circulation is determined by a dew-point apparatus, and a correction applied for the heat absorbed in evaporating water from the apples.

The results show that at a temperature of 20° C. sound apples generate heat at the rate of about 0.012 calorie per second per kilogram of apples. Or for an apple of average size ($2\frac{1}{2}$ inches in diameter), the rate of heat generation per second is one and a half thousandth calories.

A series of lantern slides illustrating Air Conditioning Experiments, with especial reference to Fruit Storage, was shown by Ezer Griffiths, D.Sc., F.R.S.

The first set described experiments on the cooling effect of metal ducts fixed on the external walls of a fruit stores. The effectiveness of the ducts was enhanced by covering them with cloth maintained moist. The second set illustrated experiments on the control of the humidity of an air stream, by passing it through sprays of calcium chloride solution of definite concentration. The density of the brine was maintained within prescribed limits by an automatic device: the movement of a float in the brine tank diverted a minute stream, either of concentrated brine or of water, into the tank according to whether the brine was being diluted or concentrated in the spraying operation. The third set of slides related to experiments in hygrometry. An apparatus had been devised for the simultaneous comparison of a number of materials, whose length is a function of the relative humidity of the atmosphere in which they are situated. The movements of the ends of strips or ligaments of the materials were magnified 20-fold. The pointers moved in close proximity to the rear face of a curved sheet of mica with scales engraged on it. Mica was found to be superior to celluloid as the latter distorted with humidity changes. Data connecting the humidity with length of a variety of substances were shown in the form of curves. The experiment had been made over a range of temperatures. Some novel forms of hygrometers were also illustrated. One simple form consisted of a pleated sheet of cellophane about 1-1000th inch in thickness suspended from the end of a light spiral spring. Changes in weight of the material, consequent on changes of humidity, were indicated by the movements

of a pointer attached to the end of the spring. Various forms of wet and dry bulb and hair hygrometers were illustrated. The fourth set of slides illustrated typical "air conditioning" equipments suitable for ordinary room temperatures.

GEOLOGICAL SOCIETY.

November 30, 1927.

Prof. D. I. Mushketov, Director of the Russian Geological Survey, gave a brief account, illustrated by lantern slides, of the results of recent work in the Alai and Trans-Alai chains in Southern Turkestan, north of the Pamirs. The first geological survey of this region was made in 1909. The results then obtained have been confirmed and amplified by the surveys of 1925 and the two succeeding years made by the speaker and by A. F. Markovski. In the western part of the Alai chain abundant confirmatory evidence was obtained of a Pamir (Alpine) system of folding, due to pressure from the south acting in Kainozoic times and causing overthrusting of Palæozoic rocks over Cretaceous and Tertiary. Observations in the western part of the Trans-Alai chain lead to the conclusion that the northern slope of this part of the chain is a large isosyncline, overturned northwards and lying nearly horizontal. Its core consists of much-folded Upper Cretaceous and Eocene marls and clays, raised by the folding to a height of some 18,000 feet. It seems likely that the whole of the Trans-Alai chain was overthrust on to the Alai chain to the north.

East of the meridan of Mount Kaufmann the direction of the whole Alai chain swings from an east-to-west to a north-to-south direction—the 'Ferghana flexure.' On the southern limb of this flexure there has occurred another great overthrust, a sheet of massive Devonian limestones have been thrust from south to north over Kainozoic and Cretaceous beds. The surface of this over-riding sheet dips distinctly south-eastwards at 35°. The observations of the recent Pamir expedition under D. V. Nalivkin confirm the views arrived at in the Alai chains.

The following paper was read :—

The Granites of the Scilly Isles ,and their Relation to the Dartmoor Granites. By CHARLES WILLIAM OSMAN, M.Inst.C.E., F.G.S.

Assuming that the whole of the granites of Devon and Cornwall are due to the same cause, late adjustments of the post-Carboniferous revolution, it is shown, by comparing the two ends of the series, that the isostatic correction-sequence of intrusions is similar in both areas.

The separate successive intrusions are tabulated for both areas in their corresponding stages.

Previous to the intrusion of the granites the South-West of England had been subjected to three separate foldings, and the position of the granite laccolites are directly related to the intersection of the ridges of these folds: (*a*) Post-Silurian, Caledonian folding; (*b*) Post-Middle Coal-Measures, Malvernian folding; and (*c*) Post-Carboniferous, Armorican folding.

Although the order of the granitic intrusions is found to be the same throughout the whole district, it would not appear that all these took place simultaneously, and reasons are given to show that the Scilly Isles and Bodmin-Moor Stage 2 A granites were intruded earlier, and had consolidated before the Dartmoor Stage 2 A was intruded.

The Scilly Isles being a typical granite-laccolite that has been dissected by Nature, afford exceptional advantages for the study of the formation of such compound intrusions, having been planed down by the advance and retreat of the seas of the Upper Cretaceous Period, the Eocene uplift, and the Pliocene sea - so that now no part rises higher than 166 feet above sea level. Also numerous cross-sections have been made by the formation of north-south sea-channels, probably due to slight further Malvernian movement.

Stage 1 is a basic microgranite found only as inclusions in Stage 2 A coarse-grained, and Stage 2 B medium-grained granites.

The directions of flow of the granite for Stages 2 A and 2 B are traced back to their inlet. Stage 3 is a fine-grained granite, *intruded after the previous stages had con-*solidated ,and it is shown that Stage 3 not only made a new inlet, but, in doing this, formed thrust-planes of low hade in Stage 2 A and Stage 2 B intrusions. The later subsidence of the inlets produced Crow Sound and St. Mary's Sound, and the age of *these inlet subsidences are possibly as late* as the Pneumatolytic Stage. Stage 4 is a later fairly large marginal intrusion of a microgranite of aplitic nature, intruded locally between Stage 2 B above and Stage 3 beneath. All these stages in Scilly entered the laccolite from the two inlets mentioned.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

At the monthly Council Meeting on December 7, Mr. H. Dent Brocklehurst reported the Committee's desire to place on record their appreciation of the services of Mr. J. L. Luddington who for the last fourteen years had been their Chairman. Throughout this period Mr. Luddington had evinced much interest in the work of the Chemical Department and had represented the Society on the Lawes Agricultural Trust, and taken his part in the framing of the Fertilisers and Feeding Stuffs Act and in other enquiries of a chemical nature. Mr. Luddington's tenure of the chairmanship of the Chemical Committee had been marked by unvarying courtesy and consideration, and his colleagues much regretted the termination of his service as their chairman.

The list of samples analysed for members by the Consulting Chemist during the month of November had been submitted to the Committee. The annual report of the Consulting Chemist had been considered by the Committee, and, subject to slight amendment, passed for publication in the next volume of the *Journal*. The operation of the new Fertilisers and Feeding Stuffs Act had been postponed until July 1, 1928.

The report of the Consulting Chemist to the Chemical Committee was as under :—

1.—*Compound Cake Differing from Published Statement of Composition.*

The agent of a large estate in Northants sent me for analysis a sample of "pig cubes," which was stated to be composed of 30 per cent. barley meal, 30 per cent. maize meal, 32 per cent. middlings, 5 per cent. whale meal, and 3 per cent. treacle. On analysing the sample I found it to differ very materially from the statement given, alike in respect of the constituent materials and the analytical composition.

Thus I found the sample to contain cottonseed, oats, linseed, rice and rape, none of which were mentioned by the seller, while the respective analyses, as shown below, were essentially dissimilar.

Analysis of sample sent: Oil, 5.68 per cent.; albuminoids, 19 per cent.; carbohydrates, 48.43 per cent.; woody fibre, 10.58 per cent.; mineral matter, 7.71 per cent.

Analysis (approximate) which sample, as guaranteed, would give : Oil. 3.7 per cent.; albuminoids, 14.4 per cent.; carbohydrates, 60.7 per cent.; woody fibre, 3.5 per cent.; mineral matter, 2.7 per cent.

It seemed that the purchaser had asked a local merchant to get a food made up for him composed of certain ingredients, and this was the result.

2.—*Condimental Foods.*

In "Occasional Notes," June, 1927, and in other reports, attention has been drawn to certain condimental foods sold at prices out of all proportion to their real value. These prices range from £40 to £58 a ton. But, in addition to this, complaint has been made to me by members of a practice that has grown up in connection with the foisting on purchasers of a delivery of the food much in excess of what was ordered. It would seem that two commercial travellers go round together and induce farmers to take some of the food by way of a trial. The latter may agree to this by ordering ½ cwt. (cost, in one case now before me 29s.); they are then asked to sign a contract form which, without their being aware of it commits them to the purchase of ½ *ton* which quantity is sent them, together with a demand note, much as follows :—

"To 10 cwt. meal, £29 10s. Price, 59s. per cwt. Guarantee : Oil, 10 per cent.; albuminoids, 15 per cent."

If the purchaser refuses to pay, he is summoned, and the signed contract is produced.

Numerous cases of this kind have been tried, notably at Derby County Court.

Up to recently, and although strong endeavours have been made by County Councils and the National Farmers' Union to "show up" the methods pursued and the exorbitant prices charged, the manufacturers have, by production of the form of contract referred to above, been able to enforce payment.

It is to be hoped that purchasers will be careful as to the form of contract they sign.

3.—*Ground Lime of Inferior Quality.*

A sample sent me from Hertfordshire gave :—

Oxide of iron and alumina	6.4[illegible]
Lime	67.5[illegible]
Silica	16.7[illegible]
Magnesia, carbonic acid, etc	9.2[illegible]
	100.0[illegible]

This was a well-burnt lime, and also finely ground, but it was made from inferior stone having over 16½ per cent. of silica, with somewhat much iron, etc. The consequence was that instead of having, as a good lime should have, 80 to 85 per cent of lime, this had only 67½ per cent., and a

the prices asked (33s. 10d. per ton delivered), was decidedly dear.

The Committee estimated that for the ensuing year their expenditure would amouut to £400, plus the amount of the Laboratory petty cash.

The Committee had met eight times and had made eight reports during the year.

The report was adopted.

FORTHCOMING EVENTS.

THE ROYAL INSTITUTION OF GREAT BRITAIN.

21, Albemarle Street, London, W.1.

Tuesday, January 3, at 3 p.m.—Third Juvenile Lecture: "Engines Which Work To and Fro." By Edward N. da C. Andrade, D.Sc., Ph.D., M.R.I.

SOCIETY OF CHEMICAL INDUSTRY.

Manchester Section, Milton Hall, Deansgate.

Friday, January 6, 1928.—"The Action of Caustic Alkali on Partially-Methylated Cellulose—The Heat of Reaction and Absorption." By F. C. Wood, M.Sc., A.T.I., and Agnes G. Alexander, B.Sc. ,A.T.I.

ROYAL MICROSCOPICAL SOCIETY.

20, Hanover Square, London, W.1.

The Annual Meeting of the Society will be held on January 18, 1928, when Dr. James A. Murray, M.D., F.R.S., P.R.M.S., will deliver the Presidential Address.

The Biological Section will meet in the Library on Wednesday, 4, January, 1928. Hon. Secretary: Professor R. Ruggles Gates, M.A., Ph.D.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, London.

Thursday, January 5, at p p.m.—"Storage Batteries in Relation to Modern Electric Lighting and Power." By E. C. McKinnon.

ROYAL INSTITUTION OF GREAT BRITAIN.

Albemarle Street, Piccadilly, W.1.

Christmas Lectnres: "Engines" by E. N. da C. Andrade, D.Sc.:—

Tuesday, January 3, 1928.—(3) "Engines Which Work To and Fro."

Thursday, January 5.—(4) "Engines Which Work Round and Round."

Saturday, January 7.—(5) "Putting the Furnace in the Cylinder."

Tuesday, January 10.—(6) "Heat Engines Which Produce Cold."

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

33,355.—Fabriques de produits de Chimie Organique de Laire.—Manufacture of primary amines. December 9th.

32,837.—Frank, A. R.—Production of hydrocyanic acid. December 5th.

33,199.—Harrison, H. A.—Manufacture of acenaphthalene derivatives. December 8th.

33,095.—Wellcome Foundation, Ltd. Preparation of soluble salts of ergot oxine. December 7th.

Specifications Published.

261,026.—Scheller, Dr. E.—Process for arsenising organic compounds.

278,301.—Lundin, B.—Method and apparatus for producing carbonic acid gas.

281,491.—I. G. Farbenindustrie Akt.-Ges.—Manufacture and production of anhydrous chlorides and hydrogen chloride.

265,959.—Riedel Akt.-Ges., J. D. Process for producing adipic acid and its alkyl substitution products.

281,530.—Abraham, Dr. A. Process for the production of a material containing thymol and polymerised formaldehyde.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

279,283.—Amino compounds; iron oxide.—I. G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany.

The reduction of aromatic nitro compounds to the corresponding amino compounds with iron and hydrochloric acid is performed with a concentration of acid substantially greater than 6 per cent., or where there is used, instead of hydrochloric acid, an acid-reacting aqueous solution of a salt of an aromatic amine, it may be of the amine to be produced, this solution is of corresponding concentration. The process results in the production of a finely divided iron oxide suitable for use as a pigment. An example is given in which nitrobenzene i reduced with iron and hydrochloric acid s

that there is produced an iron oxide which, after being freed from salts and dried, may be converted into a pigment by ignition and oxidation. Reference is made also to the use of aniline hydrochloride instead of hydrochloric acid.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

ALKA-ZANE.

485,303. Chemical substances prepared for use in medicine and pharmacy.—William R. Warner & Co., Inc., 113, West 18th Street, City and State of New York, United States of America. December 14th.

PANTERIC.

485,323.—All goods in class 3 which includes chemical substances prepared for use in medicine and pharmacy.—Parke, Davis & Company, 2951, Atwater Street, Detroit, State of Michigan, United States of America; and 50 to 51, Beak Street, Regent St., London. W.1. December 14th.

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